Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011)

Residential Sector Final Report

9 January 2012

Submitted to:
Yukon Energy, Yukon Electrical Company,
Government of Yukon

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Executive Summary

Background and Objectives

Yukon residents rely on electricity not only to live meaningful, healthy lives but also to support and strengthen the economy. Given the concerns over environmental implications including climate change, and the limited generating capacity in Yukon, there is growing interest not only in how electricity is generated, transmitted and distributed, but also in how efficiently it is used on the customer's end. In Yukon, as well as in a growing number of North American jurisdictions, how electricity is generated and used is being closely analyzed to find innovative ways of meeting individual and corporate energy service needs while minimizing pollution and the creation of greenhouse gases.

Experience throughout many North American jurisdictions has demonstrated that energy efficiency, conservation and customer-supplied alternative energy technologies all have a significant potential to reduce energy consumption, energy costs and emissions. The 2009 *Energy Strategy for the Yukon* also recognizes this potential and notes the following efficiency and conservation priorities:

- Avoid the cost and environmental impact of building new generation
- Increase energy efficiency in Yukon by 20% by 2020
- Reduce energy consumption in Yukon buildings
- Reduce energy consumption for transportation in Yukon
- Promote the use of energy efficient products by providing incentives for products that meet energy performance standards
- Improve energy efficiency for Yukon government operations.

Efficient use of electricity through conservation, peak demand control and alternative energy sources can assist greatly in the path forward for the electrical supply industry. This conservation potential review study, referenced as CPR 2011, will provide a resource for Yukon Energy Corporation (YEC), Yukon Electrical Company Limited (YECL), and the Government of Yukon to develop a comprehensive vision of the territory's future electricity service needs.

More specifically, the objective for this study is to provide:

"...a necessary reference point to determine the potential for (electricity) demand-side management (DSM) in the Yukon."[1]

Scope

The scope of this study is summarized below:

- Sector Coverage: This study addresses two sectors: residential households (Residential sector), and commercial and institutional buildings (Commercial sector). Yukon's industrial sector consists primarily of a small number of operating mines on the grid, which are not appropriate to be included in this type of study. Efficiency opportunities within these sites are being addressed outside this study.

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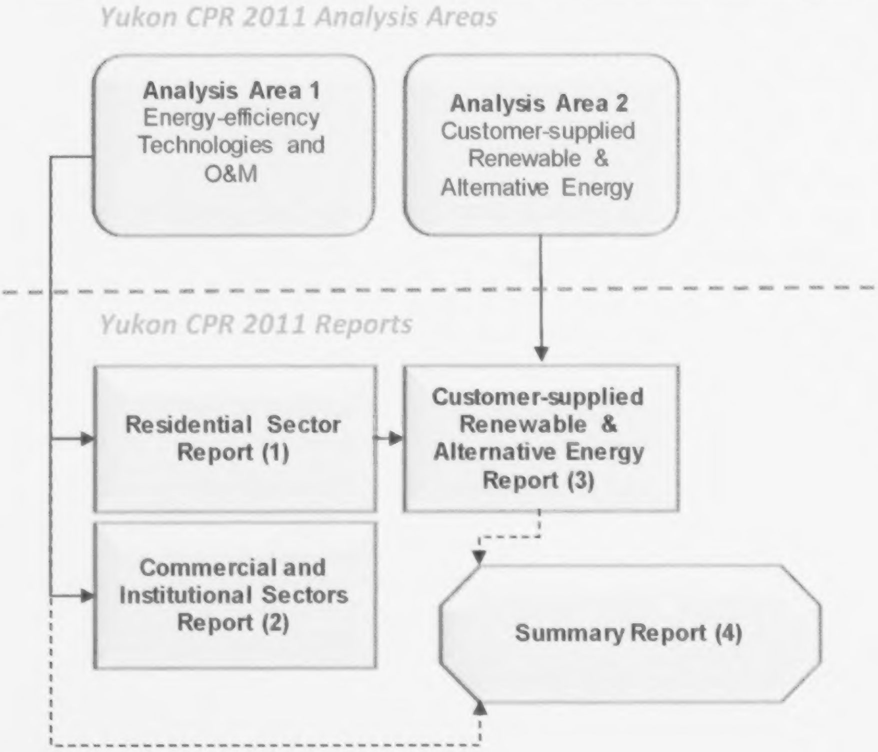
[1] Yukon Energy Corporation Request For Proposals #2010-045, "Consulting Services for Electricity Conservation and Demand Management Potential Study," 2011.

- Geographical Coverage: The study addresses all regions of Yukon that are served by either YEC or YECL. Customers served by both the hydroelectric grid and the stand-alone diesel grids are included. Note that the hydroelectric grid is remote, not connected to other grids, and dependent on trucked fuel to meet demand above the existing hydro/ wind capacity, while the stand-alone diesel grids rely on fuel that is trucked or flown in at all times.
- Study Period: This study covers a 20-year period. The Base Year is the calendar year 2010, with milestone periods at five-year increments: 2015, 2020, 2025 and 2030. The Base Year of 2010 was selected to enable this study's results to be aligned with the most recent Yukon load forecast.[2]
- Technologies: This study addresses a comprehensive range of demand-side management (DSM) measures. This includes all electrical efficiency technologies or measures that are expected to be commercially viable by the year 2015, as well as peak load reduction technologies and customer-side renewable energies.

Conservation Potential Review 2011 (CPR 2011) has been organized into four analysis areas and the results are presented in four reports, as show in Exhibit ES 1, below.

Exhibit ES 1 Overview of CPR 2011 Organization – Analysis Areas and Reports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Energy-efficiency Technologies and O&M
Analysis Area 2
Customer-supplied Renewable & Alternative Energy
Yukon CPR 2011 Reports
Residential Sector Report (1)
Customer-supplied Renewable & Alternative Energy Report (3)
Commercial and Institutional Sectors Report (2)
Summary Report (4)

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[2] Yukon Energy Corporation, *20-Year Resource Plan – 2011, First Draft*, April 2011.

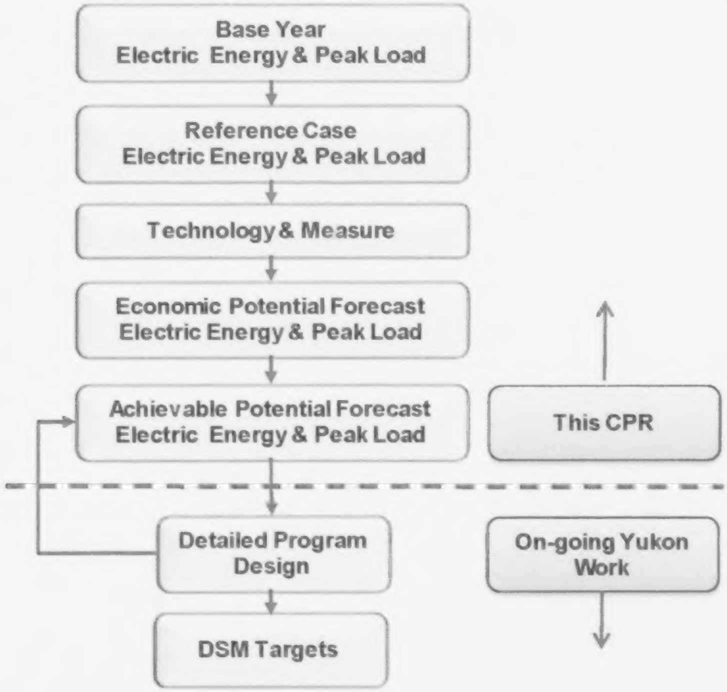
This report presents the results of Analysis Area 1: Energy-efficiency Technologies and O&M, for Residential sector customers (Report 1 in Exhibit ES 1 above). This report addresses all commercially available electric energy-efficiency and peak load reduction measures that are applicable to Yukon's Residential sector.

Approach

The detailed end-use analysis of electrical efficiency opportunities in the Residential sector employed two linked modelling platforms: HOT2000,[3] a commercially supported, residential building energy-use simulation software, and RSEEM (Residential Sector Energy End-use Model), an ICF Marbek in-house spreadsheet-based macro model. Peak load savings were modelled using Lopes Consulting Services, Inc.'s Cross-Sector Load Shape Library Model (LOADLIB).

The major steps involved in the analysis are shown in Exhibit ES 2 and are discussed in greater detail in Section 2 of this report. As illustrated in Exhibit ES 2, the results of CPR 2011, and in particular the estimation of Achievable Potential,[4] support on-going demand-side management (DSM) work; however, it should be emphasized that the estimation of Achievable Potential is not synonymous with either the setting of specific DSM targets or with program design.

Exhibit ES 2 CPR 2011: Main Analytic Steps


Base Year
Electric Energy & Peak Load
Reference Case
Electric Energy & Peak Load
Technology & Measure
Economic Potential Forecast
Electric Energy & Peak Load
Achievable Potential Forecast
Electric Energy & Peak Load
This CPR
Detailed Program Design
On-going Yukon Work
DSM Targets

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[3] Natural Resources Canada. *HOT2000 Software*. Download from: http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/software_tools/hot2000.html

[4] The proportion of savings identified that could realistically be achieved within the study period.

Overall Residential Study Findings

As in any study of this type, the results presented in this report are based on a number of important assumptions. Assumptions such as those related to the current penetration of efficient technologies and the rate of future growth in the building stock are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by the Yukon utilities and government. However, the reader is referred to a number of caveats throughout the main text of the report. Given these assumptions, the CPR 2011 findings confirm the existence of significant potential cost-effective opportunities for electric energy[5] and peak load savings in Yukon's Residential sector.

Electric energy savings from electrical efficiency improvements would provide between 22,000 and 37,000 MWh/yr. of electricity savings by 2030 in, respectively, the lower and upper Achievable scenarios. The most significant Achievable Savings opportunities were in the actions that addressed space heating. Significant savings were also found in domestic hot water systems, clothes dryers,[6] standby load in household electronics (e.g., computers and their peripherals, televisions, and other home entertainment electronics), and 13 other end uses.

The electric energy savings noted above would provide peak load savings of approximately 6.4 to 10.5 MW during Yukon's annual system peak hour by 2030 in, respectively, the lower and upper Achievable scenarios.[7]

Summary of Electric Energy Savings in the Residential Sector

A summary of the levels of annual electricity consumption contained in each of the forecasts addressed by CPR 2011 is presented in Exhibit ES 3 and Exhibit ES 4, by milestone year.

Exhibit ES 3 Electricity Savings by Milestone Year for Three Scenarios (MWh/yr.)

Year	Economic Potential Scenario		Upper Achievable Potential Scenario		Lower Achievable Potential Scenario	
	Potential Savings (MWh/yr.)	% Savings Relative to Ref Case	Potential Savings (MWh/yr.)	% Savings Relative to Ref Case	Potential Savings (MWh/yr.)	% Savings Relative to Ref Case
2015	37,234	24%	5,114	3%	2,711	2%
2020	42,572	25%	13,554	8%	7,792	5%
2025	49,415	25%	23,598	12%	13,539	7%
2030	57,246	25%	37,097	16%	22,239	10%

*Results are measured at the customer's point-of-use and do not include line losses.

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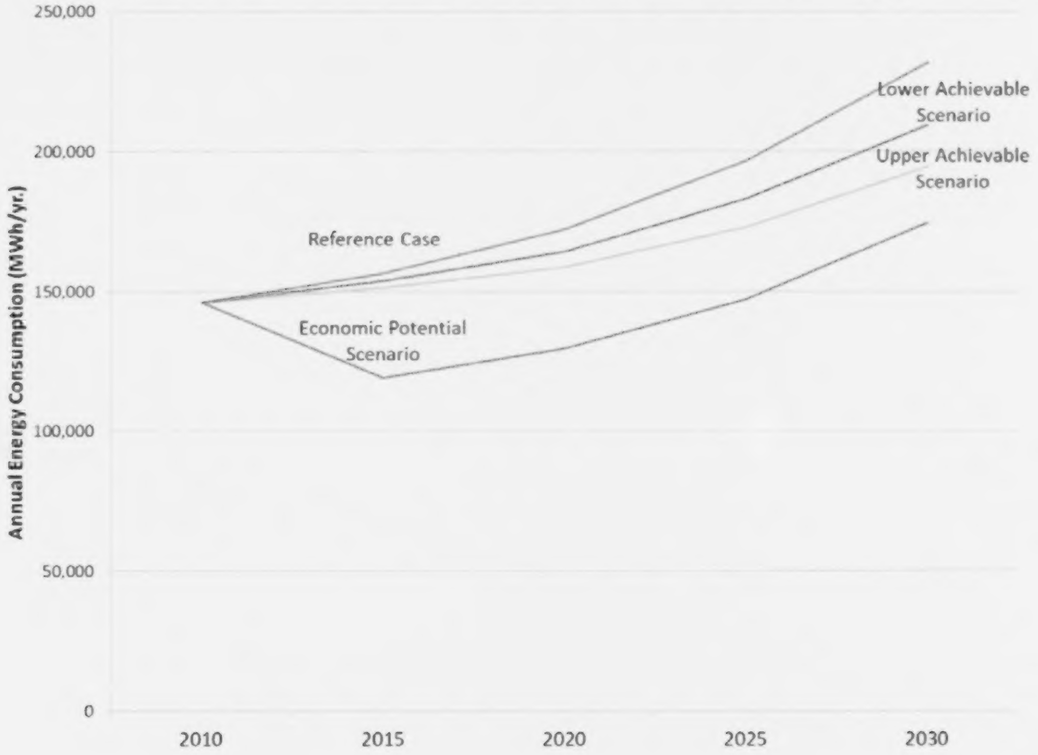
[5] The term "electric energy" is used in this report to distinguish electricity consumption (in units of kWh or MWh) from electricity demand during a specific period (in units of MW).

[6] Savings in the clothes dryers result from the faster spin cycle in energy-efficient clothes washers. Spinning the clothes more thoroughly in the washer reduces the runtime of the clothes dryer.

[7] These reduction estimates do not include the change in load shape that results when timers are used on block heaters. In fact, if timers are used, close to 90% of the peak load caused by block heaters would be eliminated because the block heater load at most homes with timers would not begin until the early hours of the morning. At the same time, the figures include an overestimate of peak impact from space heating measures because the heat pump measures do not offer demand reductions. These effects almost cancel out: the range of peak savings is between 6.6 MW and 9.9 MW if they are included.

Exhibit ES 4 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Residential Sector, (MWh/yr.)



Base Year Electricity Use

In the Base Year of 2010, Yukon's Residential sector consumed about 146,000 MWh. Exhibit ES 5 shows that domestic hot water and space heating each account for about 19% of total residential electricity use. These are followed by spa heaters and pumps with about 9%, indoor lighting with 8%, and computers (with their peripherals) and clothes dryers with about 7% each. Refrigerators account for 6%, followed by cooking, ventilation/circulation, and freezers with 4% each. Other end uses account for 3% or less of the total. The same exhibit also presents the Reference Case consumption by end use in 2030, at the end of the study period, for comparison.

Exhibit ES 6 shows the distribution of Base Year electricity consumption by dwelling type. As illustrated, single detached housing dwellings account for the largest share (72%) of Residential sector Base Year electricity use. The same exhibit also presents the Reference Case consumption by dwelling type in 2030, at the end of the study period, for comparison.

Reference Case – Electric Energy

In the absence of new DSM initiatives, CPR 2011 estimates that electricity consumption in the Residential sector will grow from 146,000 MWh/yr. in 2010 to about 232,000 MWh/yr. by 2030. This represents an overall growth of about 59% in the period and is higher than the forecast set out in YEC's 20-Year Resource Plan – 2011. This is largely because projections of construction of electrically heated residential dwellings have been revised since the publication of that forecast.

Exhibit ES 5 below shows the expected change in energy consumption by end use by 2030, in the absence of new DSM initiatives. Space heating is expected to rise to 24% of residential electricity consumption, while domestic hot water is expected to fall to 13%. These will be followed by computers (with their peripherals) at 10%, small appliances and other (including as yet unknown end uses), also at 10%, clothes dryers at 6%, home entertainment electronics and indoor lighting at 5% each, and refrigerators at 4%. Other end uses each account for 3% or less of the total.

Exhibit ES 6 below shows the expected change in energy consumption by dwelling type in 2030, in the absence of new DSM initiatives. As illustrated, single detached housing dwellings are expected to account for a somewhat smaller share (65%) of overall residential consumption. The biggest increase is expected to be in apartment buildings, because of their higher rate of construction and because so many of them are expected to be electrically heated. Over the study period, they are expected to rise from approximately 9% of residential consumption in 2010 to approximately 17% in 2030.

Exhibit ES 5 Base Year Electricity Use by End Use, Residential Sector

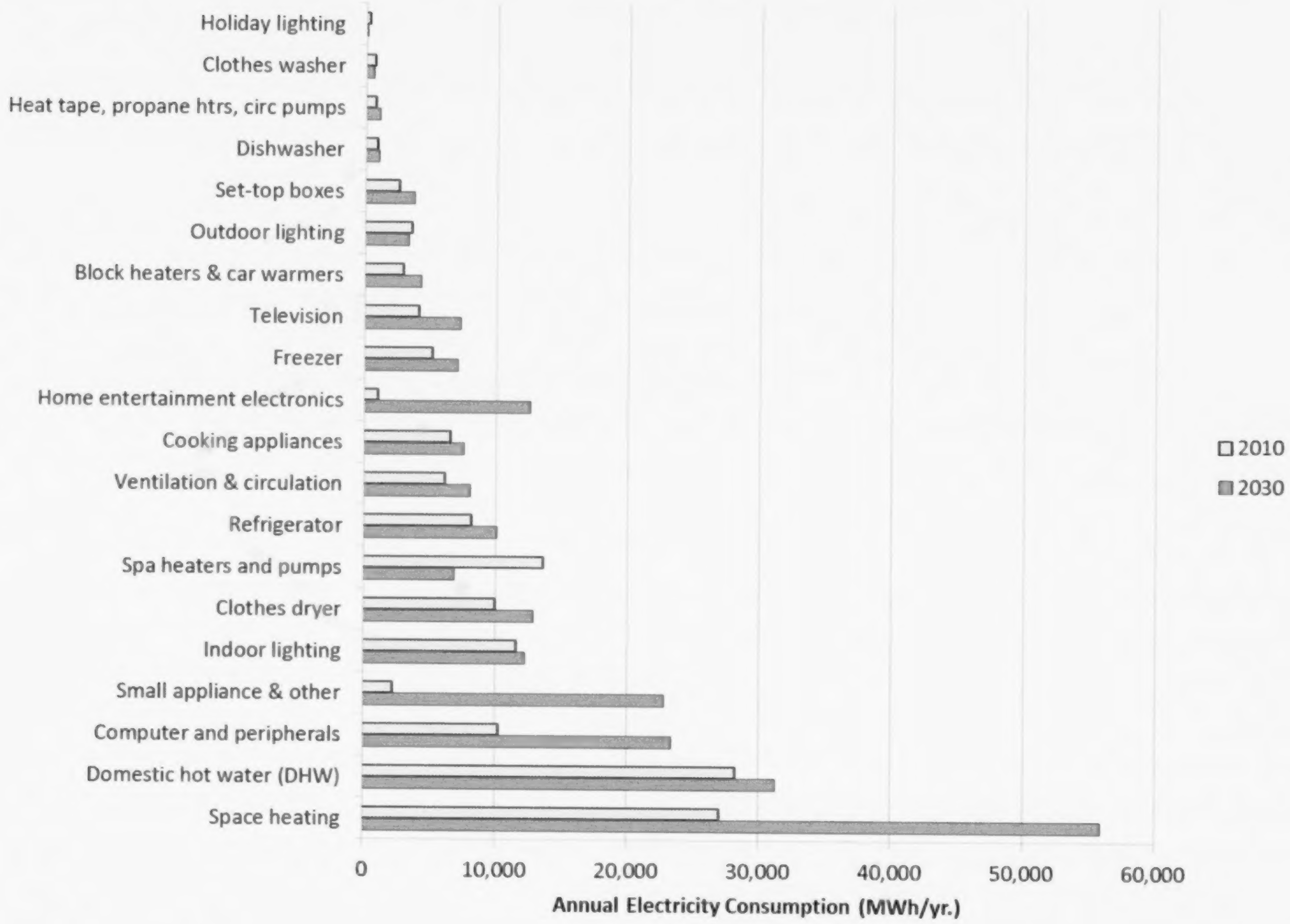
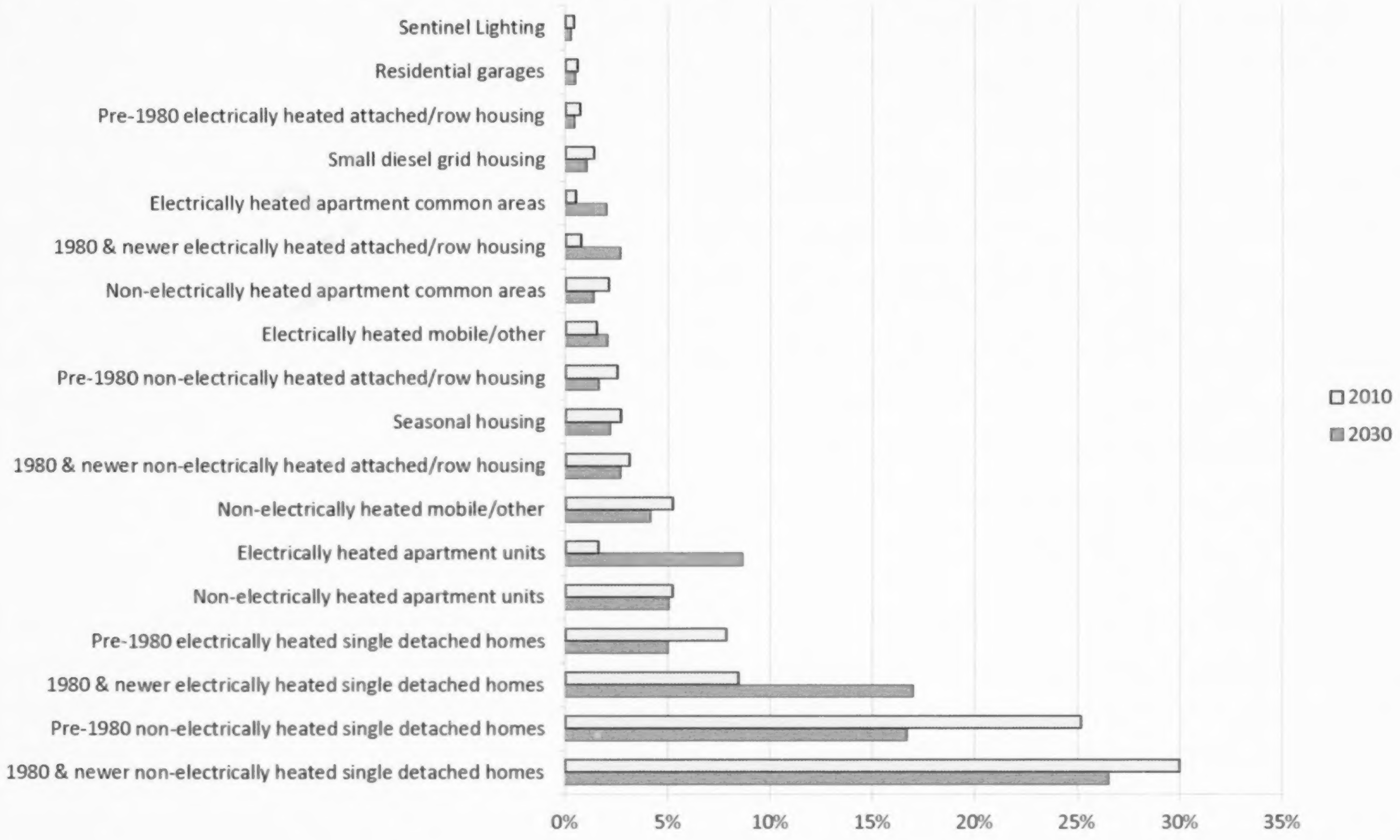


Exhibit ES 6 Base Year Electricity Use by Dwelling Type, Residential Sector



Economic Potential Forecast – Electric Energy

Under the conditions of the Economic Potential Forecast,[8] the study estimated that electricity consumption in the Residential sector would grow to about 174,000 MWh/yr. by 2030. Annual savings relative to the Reference Case are 57,000 MWh/yr. or about 25%. The Economic Potential annual savings in the intermediate milestone years are 37,000 MWh/yr. in 2015, 43,000 MWh/yr. in 2020, and 49,000 MWh/yr. in 2025.

Achievable Potential – Electric Energy

The Achievable Potential is the proportion of the economic electric energy savings (as noted above) that could realistically be achieved within the study period. In the Residential sector, the Achievable Potential for electric energy savings through technology adoption was estimated to be 22,000 MWh/yr. and 37,000 MWh/yr. by 2030 in, respectively, the lower and upper scenarios.

Consistent with the results in the Economic Potential Forecast, the most significant Achievable savings opportunities were in the actions that addressed space heating. Significant savings can also be found in domestic hot water, clothes dryers, standby load in household electronics (e.g., computers and their peripherals, televisions and other home entertainment electronics), and 13 other end uses.

Summary of Peak Load Savings

Based on discussions with utility personnel, the following three peak period definitions were selected for inclusion in this study:

- Peak Period 1: Annual System Peak Hour – This has traditionally been the hour ending at 6 pm on a day in December; it is highly correlated with the coldest day of the year when occurring in December, although it has sometimes occurred in January.
- Peak Period 2: Annual Weekday System Evening Peak Period – The 4-8 pm period on the coldest four days of the year when occurring in December or January (total 16 hours).
- Peak Period 3: Annual Weekday System Morning Peak Period – The 7-9 am period on the 10 coldest days of the year when occurring in December or January (total 20 hours).

Exhibit ES 7 provides a summary of the peak load savings from the electric energy savings, for the Annual Peak Hour. Details for the other two peak periods are provided in the main body of the report. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case.

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[8] The level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective against future avoided electricity costs.

Exhibit ES 7 Residential Peak Load Reductions for Annual Peak Hour, from Electric Energy Savings Measures, Reference Case, Economic and Achievable Scenarios (MW)

Milestone Year	Period 1: Annual Peak Hour							
	Base Year	Reference Case	Peak Load Reduction from Electric Energy Savings					
			Economic		Upper Achievable		Lower Achievable	
2010	34.5	34.5						
2015		37.3	10.0	27%	1.3	3%	0.8	2%
2020		41.2	11.3	28%	3.6	9%	2.3	6%
2025		46.6	13.0	28%	6.5	14%	3.9	8%
2030		54.0	14.9	28%	10.5	19%	6.4	12%

Highlights of the peak load savings shown in Exhibit ES 7 above are presented below:

- In the Base Year 2010, the peak load for Yukon's total Residential sector was approximately 34.5 MW for the Annual Peak Hour.
- The study estimates that the Residential sector peak load in the Annual Peak Hour will grow to 54 MW by 2030, an increase of about 57%.
- Electric energy savings would provide peak load savings of approximately 6.4 to 10.5 MW (12% to 19%) during Yukon's Annual Peak Hour by 2030 in, respectively, the lower and upper Achievable scenarios.

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1 Introduction

1.1 Background and Objectives

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[9] Yukon Energy Corporation Request For Proposals #2010-045, "Consulting Services for Electricity Conservation and Demand Management Potential Study," 2011.

1.2 Study Scope

The scope of this study is summarized below:

- Sector Coverage: This study addresses two sectors: residential households (Residential sector), and commercial and institutional (Commercial sector). Yukon's industrial sector consists primarily of a small number of operating mines on the grid, which are not appropriate to be included in this type of study. Efficiency opportunities within these sites are being addressed outside this study.

- Geographical Coverage: The study addresses all regions of Yukon that are served by either YEC or YECL. Customers served by both the hydroelectric grid and the stand-alone diesel grids are included. Note that the hydroelectric grid is remote, not connected to other grids, and dependent on trucked fuel to meet demand above the existing hydro/ wind capacity, while the stand-alone diesel grids rely on fuel that is trucked or flown in at all times.

- Study Period: This study covers a 20-year period. The Base Year is the calendar year 2010, with milestone periods at five-year increments: 2015, 2020, 2025 and 2030. The Base Year of 2010 was selected to enable this study's results to align with the most recent Yukon load forecast.[10]

- Technologies: This study addresses a comprehensive range of electric demand-side management (DSM) measures. This includes all electrical efficiency technologies or measures that are expected to be commercially viable by the year 2015 as well as peak load reduction technologies and customer-side renewable energies.

1.2.1 Data Caveat

As in any study of this type, the results presented in this report are based on a large number of important assumptions. Assumptions such as those related to the current penetration of energy-efficient technologies, the rate of future growth in the stock of residential buildings and customer willingness to implement new energy-efficiency measures are particularly influential. Wherever possible, the assumptions used in this study are consistent with those used by YEC, YECL, and the Government of Yukon and are based on best available information, which in many cases includes the professional judgment of the consultant team, client personnel and local experts. The reader should, therefore, use the results presented in this report as best available estimates; major assumptions, information sources and caveats are noted throughout the report.

1.3 Study Organization

Exhibit 1 presents an overview of the study's organization; as illustrated, the study has been organized into two analysis areas and four individual reports.

A brief description of each analysis area and its report content is provided below.

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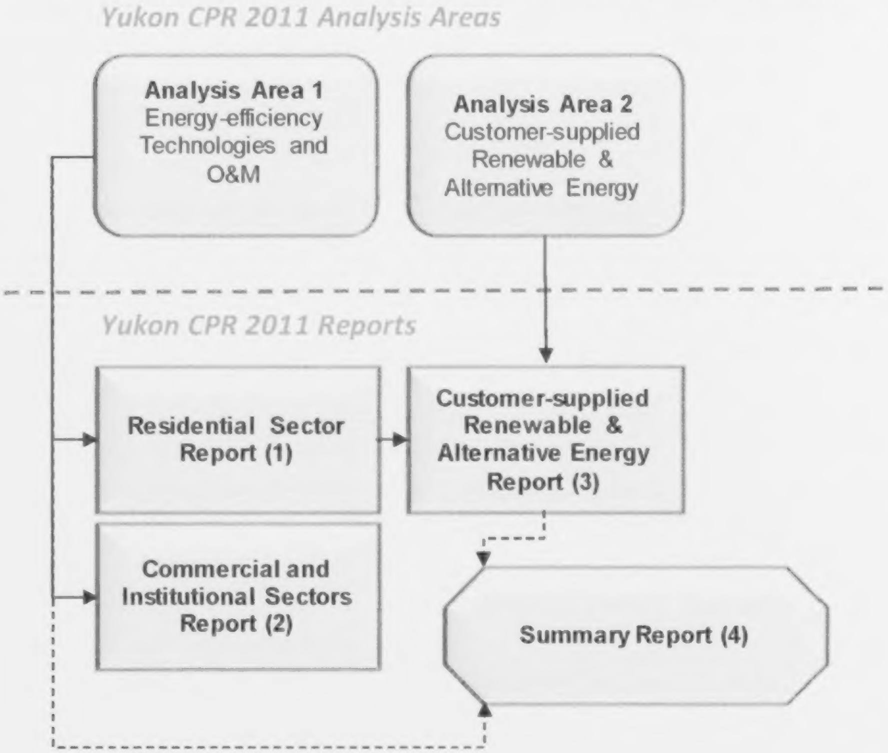
[10] Yukon Energy Corporation, *20-Year Resource Plan – 2011, First Draft*, April 2011.

Exhibit 1 Overview of CPR 2011 Organization – Analysis Areas and Reports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1.3.1 Analysis Area 1 – Energy-efficiency and Peak Load Technologies and O&M

This area of the CPR 2011 assesses electric energy[11] and peak load reduction opportunities that could be provided by electrical efficiency and peak load reduction technologies that are expected to be commercially viable by the year 2015; operation and maintenance (O&M) practices are also addressed. The results of Analysis Area 1 are presented in two individual sector reports and summarized in a Summary Report.

1.3.2 Analysis Area 2 – Customer-Supplied Renewable Energies

This area of the CPR 2011 assesses electric energy and peak load reduction opportunities that could be provided by customer-supplied renewable energies. The results of Analysis Area 2 are presented in a single report and summarized in a Summary Report.

1.4 Report Organization

This report presents the Residential sector results. It is organized and presented as follows:

- Section 2 presents an overview of the study methodology, including a definition of key terms and an outline of the major analytic steps involved.

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[11] The term "electric energy" is used in this report to distinguish electricity consumption (in units of kWh or MWh) from electricity demand during a specific period (in units of MW).

- Section 3 presents a profile of Residential sector Base Year electricity use in Yukon.
- Section 4 presents a profile of Residential sector Base Year electric peak load, including the definition of peak periods that are included in this study.
- Section 5 presents the Reference Case, which provides a detailed estimate of electricity use in Yukon's Residential sector over the study period 2010 to 2030, in the absence of new utility DSM program initiatives.
- Section 6 presents the Reference Case electric peak loads, which provide a detailed estimate of peak load requirements in Yukon's Residential sector over the study period 2010 to 2030, in the absence of new utility DSM program initiatives.
- Section 7 identifies and assesses the economic attractiveness of the selected energy-efficiency technology measures for the Residential sector.
- Section 8 presents the Residential sector Economic Potential Electricity Forecast for the study period 2010 to 2030.
- Section 9 identifies and assesses the economic attractiveness of selected Residential sector electric capacity-only peak load reduction measures, which in this study are defined as those measures that affect electric peak but have minimal or no impact on daily, seasonal or annual electricity use.
- Section 10 presents the estimated upper and lower Achievable Potential for electric energy savings for the study period 2010 to 2030.
- Section 11 lists sources and references.
- Section 12 is the Glossary.

1.5 Results Presentation

The preparation of Conservation Potential Reviews involves the compilation and analysis of an enormous amount of market and technology data and a nearly infinite number of ways of organizing and presenting the results. It is recognized that readers will have differing levels of needs with respect to the level of detail provided. Consequently, the results of this CPR are presented at three levels of detail.

- **Main report body.** The main body of the report provides a relatively high-level reporting of the main steps involved in undertaking each stage of the study together with a concise summary of results, including comments and interpretation of key findings. It is assumed that the content and level of detail in the main report body is suitable for the majority of readers who wish to gain an understanding of the potential contribution of DSM options to Yukon's long-term electricity requirements.
- **Appendices.** A separate appendix accompanies each major section of the main report. Each appendix provides more detailed information on the methodology employed, including major assumptions or sample calculations as applicable, together with additional levels of results. It is assumed that this presentation is better suited to DSM analysts and managers wishing a more thorough understanding of the study results.

- **Software.** All of the data generated by the study is provided in two custom-designed Excel models: Data Manager and the measure TRC (total resource cost) model.
    - **Data Manager** is a custom-designed Excel workbook with query protocols that enable the user to search and report the study results in a virtually infinite number of combinations. Data Manager is intended to support the most detailed level of DSM activity such as program design, preparation of regulatory submissions, etc.
    - **The measure TRC model** is a custom-designed model that provides comprehensive profiles of the DSM measures assessed within the study. Because the information is provided in software form, any changes to economic, financial or performance data inputs can be easily accommodated and revised results generated automatically.

2 Study Methodology

This section provides an overview of the methodology employed for this study. More specifically, it addresses:

- Definition of terms
- Major analytic steps
- Analytic models.

2.1 Definition of Terms

This study uses numerous terms that are unique to analyses such as this one and consequently it is important to ensure that readers have a clear understanding of what each term means when applied to this study.

A brief description of some of the most important terms and their application within this study is included below.

Base Year Electricity Use	The Base Year is the starting point for the analysis. It provides a detailed description of where and how electrical energy is currently used in the existing building stock. Building electricity use simulations were undertaken for the major sub sector types and calibrated to actual utility customer billing data for the Base Year. As noted previously, the Base Year for this study is the calendar year 2010.
Base Year Electric Peak Load Profile	Electric peak load profiles refer to specific time periods throughout the year when Yukon's generation, transmission and distribution system experiences particularly high levels of electricity demand. These periods are of particular interest to system planners; improved management of electricity demand during these peak periods may enable deferral of costly system expansion. This study addresses three specific peak periods, as outlined in the main text.
Reference Case Electricity Use (includes "natural" conservation)	The Reference Case electricity use estimates the expected level of electrical energy consumption that would occur over the study period in the absence of new (post-2010) utility-based DSM initiatives. It provides the point of comparison for the subsequent calculation of Economic and Achievable electricity savings potentials. Creation of the Reference Case required the development of profiles for new buildings in each of the sub sectors, estimation of the expected growth in building stock, and finally an estimation of "natural" changes affecting electricity consumption over the study period. The Reference Case is calibrated to YEC's most recent load forecast, minus the impacts of new, future DSM initiatives.

Reference Case Electric Peak Load Profile	The Reference Case peak load profile estimates the expected electric peak loads in each of the three defined peak periods over the study period in the absence of new utility DSM program initiatives. It provides the point of comparison for the subsequent calculation of Economic and Achievable Potentials for peak load reduction.
Demand-Side Management (DSM) Measures	DSM measures can include energy efficiency (use more efficiently), energy conservation (use less), demand management (use less during peak periods), fuel switching (use a different fuel to provide the energy service) and customer-side generation (displace load off of grid). Fuel switching is not included in this study.
The Cost of Conserved Energy (CCE)	The CCE is calculated for each energy-efficiency technology measure. The CCE is the annualized incremental capital and O&M cost of the upgrade measure divided by the annual energy savings achieved, excluding any administrative or program costs. The CCE represents the cost of conserving one kWh of electricity; it can be compared directly to the cost of supplying one new kWh of electricity.
The Cost of Electric Peak Reduction (CEPR)	The CEPR for a peak load reduction measure is defined as the annualized incremental capital and O&M cost of the measure divided by the annual peak reduction achieved, excluding any administrative or program costs. The CEPR represents the cost of reducing one kW of electricity during a peak period; it can be compared to the cost of supplying one new kW of electric capacity during the same period.
Electric Capacity-Only Peak Load Reduction Measures	Capacity-only measures are technologies or activities that result in the shifting of certain electrical loads from periods of peak system demand to periods of lower system demand.
Economic Potential Electricity Forecast	The Economic Potential Electricity Forecast is the level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective against the economic threshold value[12], which has been set at different prices per kWh for the different supply system types. (One kWh from the hydroelectric grid is much less expensive than one kWh from the diesel grid in Old Crow.) All the energy-efficiency upgrades included in the technology assessment that had a CCE equal to, or less than, the economic threshold value for a given supply system were incorporated into the Economic Potential Forecast.

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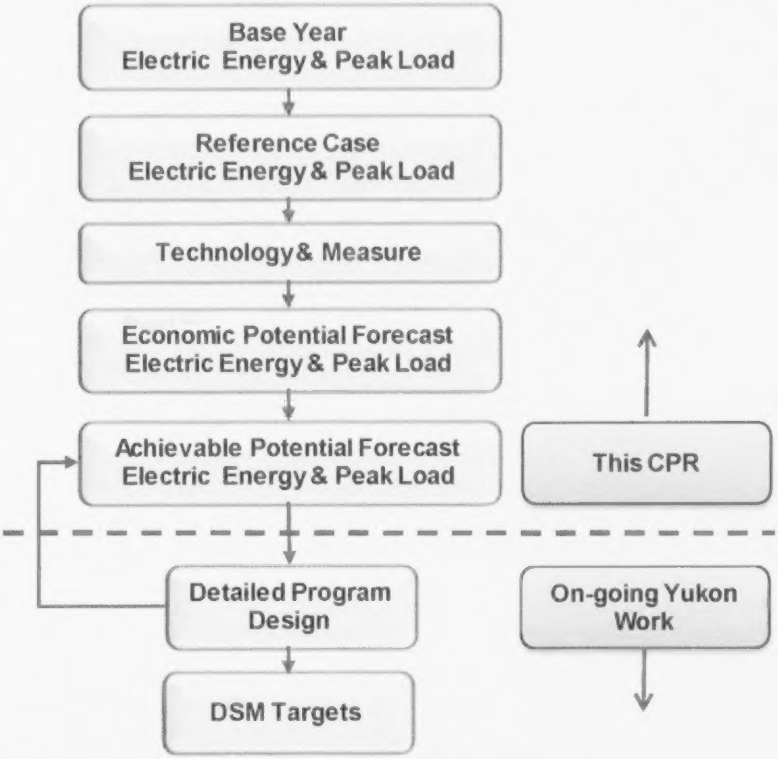
[12] The economic threshold value is related to the cost of new avoided electrical supply. The values for each supply system were selected to provide the CPR with a reasonably useful time horizon (life) to allow planners to examine options that may become more cost effective over time. Further discussion is provided in Section 7 of this report.

Economic Potential Electric Peak Load Forecast	The Economic Potential Electric Peak Load Forecast is the expected electric peak loads that would occur in each of the three defined peak periods if all peak load reduction measures that are cost effective against the future avoided cost of new capacity in Yukon were fully implemented.
Achievable Potential	The Achievable Potential is the proportion of the savings identified in the Economic Potential Forecasts that could realistically be achieved within the study period. The achievable Potential recognizes that it is difficult to induce customers to purchase and install all the electrical efficiency technologies that meet the criteria defined by the Economic Potential Forecast. The results are presented as a range, defined as lower and upper.

2.2 Major Analytic Steps

The study was conducted within an iterative process that involved a number of well-defined steps, as illustrated in Exhibit 2.

Exhibit 2 Major Analytic Steps


Base Year
Electric Energy & Peak Load
Reference Case
Electric Energy & Peak Load
Technology & Measure
Economic Potential Forecast
Electric Energy & Peak Load
Achievable Potential Forecast
Electric Energy & Peak Load
This CPR
Detailed Program Design
On-going Yukon Work
DSM Targets

A summary of the steps is presented below.

Step 1: Develop Base Year Electric Energy and Peak Load Calibration Using Actual Utility Billing Data

Build a model of electric energy and demand for the sector, disaggregated to all the building types and end uses, calibrated to sales of electricity in Yukon. This includes the following sub-steps:

- Compile and analyze available data on Yukon's existing building stock.
- Develop detailed technical descriptions of the existing building stock.
- Undertake computer simulations of electricity use in each building type and compare these with actual building billing and audit data.
- Compile actual utility billing data.
- Create sector model inputs and generate results.
- Calibrate sector model results using actual utility billing data.
- Use end-use load shape data to convert electric energy use to electric demand in each selected peak period.

Step 2: Develop Reference Case Electric Energy Use and Peak Load Profile

Extend the base year model to the end of the study period, based on forecast building stock growth and expected natural changes in construction practices, equipment efficiency levels and/or practices. This includes the following sub-steps:

- Compile and analyze building design, equipment and operations data and develop detailed technical descriptions of the new building stock.
- Develop computer simulations of electricity use in each new building type.
- Compile data on forecast levels of building stock growth and "natural" changes in equipment efficiency levels and/or practices.
- Define sector model inputs and create forecasts of electricity use for each of the milestone years.
- Compare sector model results with load forecasting data provided by YEC for the study period.
- Use end-use load shape data to convert electric energy use to electric demand in each selected peak period over the study period.

Step 3: Identify and Assess Energy-efficiency and Peak Load Reduction Measures

Compile information on upgrade measures that can save electric energy and/or reduce peak demand, and assess them for technical applicability and economic feasibility. This includes the following sub-steps:

- Develop list of energy-efficiency upgrade and peak load reduction measures.
- Compile detailed cost and performance data for each measure.
- For energy-efficiency measures, identify the baseline technologies employed in the Reference Case, develop energy-efficiency upgrade options and associated electricity savings for each option, and determine the CCE for each upgrade option.
- For each peak load reduction measure, identify the affected end use, the potential load reduction or off-peak shifting and determine the CEPR.
- Based on the above results, prepare summary tables that show the amount of potential peak load reduction provided by each measure and at what cost ($/kW/yr.).

- Apply each peak load reduction measure to the affected end use, regardless of cost, and determine total peak reduction.
- Summarize the peak load reduction impacts in a supply curve.

Step 4: Estimate Economic Electric Energy Savings Potential

Develop an estimate of the electric energy savings potential that would result from implementing all of the economically feasible measures in all the buildings where they are applicable. This includes the following sub-steps:

- Compile utility economic data on the forecast cost of new electricity generation and set an economic threshold value; different economic threshold values were selected for each supply system (hydroelectric and diesel grids).
- Identify the combinations of energy-efficiency upgrade options and building types where the cost of saving one kilowatt of electricity is equal to, or less than, the cost of new electricity generation.
- Apply the economically attractive electrical efficiency measures from Step 3 within the energy-use simulation model developed previously for the Reference Case.
- Determine annual electricity consumption in each building type and end use when the economic efficiency measures are employed.
- Compare the electricity consumption levels when all economic efficiency measures are used with the Reference Case consumption levels and calculate the electricity savings.

Step 5: Estimate Achievable Potential Electricity Savings

Develop an estimated range for the portion of economic potential savings that would likely be achievable within realistic DSM programs. This includes the following sub-steps:

- Bundle the electric energy and peak load reduction opportunities identified in the Economic Potential Forecasts into a set of opportunities.
- For each of the identified opportunities, create an Opportunity Profile that provides a high-level implementation framework, including measure description, cost and savings profile, target sub sectors, potential delivery allies, barriers and possible synergies.
- Review historical achievable program results and prepare preliminary Assessment Worksheets.
- Conduct a full day workshop involving the client, the consultant team, trade allies and technical experts to reach general agreement on the upper and lower range of Achievable Potential.

Step 6: Estimate Peak Load Impacts of Electricity Savings

Develop an estimate for the peak load impacts associated with the measures that save electric energy. This includes the following sub-steps:

- The electricity (electric energy) savings (MWh) calculated in the preceding steps were converted to peak load (electric demand) savings (kW).[13]

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[13] Peak load savings were modelled using the Cross-Sector Load Shape Library Model (LOADLIB).

- The conversion of electricity savings to hourly demand drew on a library of specific sub sector and end-use electricity load shapes. Using the load shape data, the following steps were applied:
    - Annual electricity savings for each combination of sub sector and end use were disaggregated by month
    - Monthly electricity savings were then further disaggregated by day type (weekday, weekend day and peak day)
    - Finally, each day type was disaggregated by hour.

2.3 Analytical Models

The analysis of the Residential sector employed two linked modelling platforms:

- HOT2000,[14] a commercially supported, residential building energy-use simulation software
- RSEEM (Residential Sector Energy End-use Model), an ICF Marbek in-house spreadsheet-based macro model.

HOT2000 was used to define household heating, cooling and domestic hot water (DHW) electricity use for each of the residential building archetypes. HOT2000 uses state-of-the-art heat loss/gain and system modelling algorithms to calculate household electricity use. It addresses:

- Electric, natural gas, oil, propane and wood space heating systems
- DHW systems from conventional to high-efficiency condensing systems
- The interaction effect between space heating appliances and non-space heating appliances, such as lights and refrigerators.

The outputs from HOT2000 provide the space heating/cooling energy-use intensity (EUI) inputs for the thermal archetype module of RSEEM.
RSEEM consists of three modules:

- A general parameters module that contains general sector data (e.g., number of dwellings, growth rates, etc.)
- A thermal archetype module, as noted above, which contains data on the heating and cooling loads in each archetype
- An appliance module that contains data on appliance saturation levels, fuel shares, unit electricity use, etc.

RSEEM combines the data from each of the modules and provides total use of electricity by service region, dwelling type and end use. RSEEM also enables the analyst to estimate the impacts of the electrical efficiency measures on a utility's on-peak system demand.

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[14] Natural Resources Canada. *HOT2000 Software*. Download from: http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/software_tools/hot2000.html

3 Base Year (2010) Electric Energy Use

3.1 Introduction

This section provides a profile of Base Year (2010) electricity use in Yukon's Residential sector. The discussion is organized into the following sub sections:

- Base Year housing stock
- End uses
- Average electricity use per unit
- Summary of model results.

3.2 Base Year Housing Stock

The first major task in developing the profile of Base Year electricity use involved the segmentation of the residential building stock on the basis of five factors:

- Dwelling type
- Supply system (hydro versus three diesel supply systems)
- Government of Yukon versus non-government accounts
- Vintage
- Heating category (electrically heated versus non-electrically heated).

Based on discussions with YEC, YECL and Government of Yukon personnel, it was agreed that Yukon's existing residential stock would be segmented into the following dwelling types:

- Pre-1980 electrically heated single detached homes
- 1980 & newer electrically heated single detached homes
- Pre-1980 non-electrically heated single detached homes
- 1980 & newer non-electrically heated single detached homes
- Pre-1980 electrically heated attached/row housing
- 1980 & newer electrically heated attached/row housing
- Pre-1980 non-electrically heated attached/row housing
- 1980 & newer non-electrically heated attached/row housing
- Existing electrically heated apartment/condo units
- Existing electrically heated apartment/condo common areas
- Existing non-electrically heated apartment/condo units
- Existing non-electrically heated apartment/condo common areas
- Existing electrically heated mobile/other
- Existing non-electrically heated mobile/other
- Seasonal housing
- Residential garages
- Sentinel lighting.

As much as possible, utility customer billing data was used to develop a breakdown of the Residential sector into the above dwelling types. Where billing data did not provide sufficient detail to subdivide accounts into these groups, it was augmented with housing data from the Yukon Housing Corporation and the results of Yukon's Residential Electrical End-Use Survey (REEUS).

Seasonal housing accounts were separated from the remaining population of housing by identifying accounts that had consumption of less than 3,000 kWh/yr. These accounts were separated in order to develop a more realistic average consumption for the dwellings that are fully occupied throughout the year.

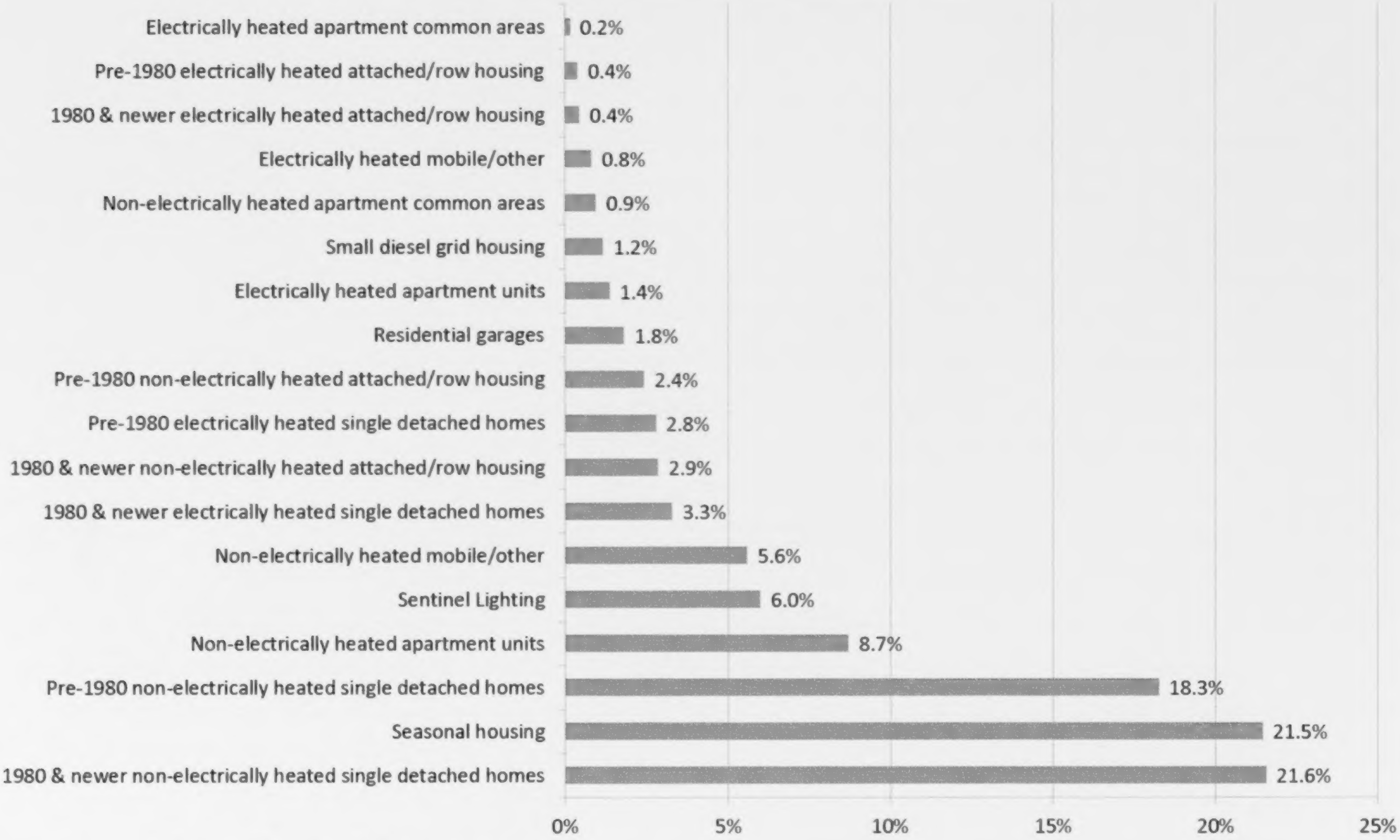
In two of the supply system categories (Small Diesel and Old Crow), the number of dwellings was too small to permit the detailed division outlined above. In those two categories, except for the garages identified in the billing data and the seasonal houses separated as above, the remaining dwellings were grouped in a category called Small Grid Housing.

A summary of the distribution of Yukon's residential dwellings is provided in Exhibit 3 and Exhibit 4. The first exhibit provides details of the estimated breakdown by dwelling type, supply system type and Government of Yukon versus non-government accounts. The bar chart shows the breakdown by dwelling type graphically, sorted from the most numerous to least numerous dwelling types.

Exhibit 3 Existing Yukon Residential Units by Dwelling Type, Supply System, and Government versus Non-government Categories

Dwelling Types	Dwelling Units								
	Hydro Grid		Large Diesel		Small Diesel		Old Crow		Total
	Non-government	Government	Non-government	Government	Non-government	Government	Non-government	Government	
1980 & newer non-electrically heated single detached homes	3,177	38	179	11	-	-	-	-	3,405
Pre-1980 non-electrically heated single detached homes	2,691	33	151	9	-	-	-	-	2,884
1980 & newer electrically heated single detached homes	513	6	-	-	-	-	-	-	519
Pre-1980 electrically heated single detached homes	434	5	-	-	-	-	-	-	439
1980 & newer non-electrically heated attached/row housing	421	5	24	1	-	-	-	-	451
Pre-1980 non-electrically heated attached/row housing	356	4	20	1	-	-	-	-	381
1980 & newer electrically heated attached/row housing	68	1	-	-	-	-	-	-	69
Pre-1980 electrically heated attached/row housing	58	1	-	-	-	-	-	-	59
Non-electrically heated apartment units	1,271	61	42	2	-	-	-	-	1,376
Non-electrically heated apartment common areas	132	15	2	1	-	-	-	-	150
Electrically heated apartment units	205	10	-	-	-	-	-	-	215
Electrically heated apartment common areas	21	3	-	-	-	-	-	-	24
Non-electrically heated mobile/other	802	3	79	0	-	-	-	-	884
Electrically heated mobile/other	129	-	-	-	-	-	-	-	129
Small diesel grid housing	-	-	-	-	88	19	64	12	184
Seasonal housing	3,041	44	171	11	56	-	65	-	3,388
Residential garages	263	1	16	-	4	-	-	-	284
Sentinel Lighting	798	-	85	-	62	-	2	-	947
Grand Total	14,378	231	769	37	211	19	131	12	15,787

Exhibit 4 Existing Yukon Residential Units by Dwelling Type



Totals may not add to 100% due to rounding.

As illustrated in Exhibit 3:

- The Yukon electric utilities currently service about 15,787 residential accounts.
- Approximately 92.5% of residential accounts are connected to the hydro grid and just over 5% are connected to large diesel systems. Approximately 1.5% are connected to small diesel systems and an additional nearly 1% of dwellings are located in Old Crow, a fly-in community also served by a small diesel system.
- Nearly 2% of residential accounts are Government of Yukon accounts. The other 98% are not.
- 46% of the residential accounts are single detached homes, just over 10% are apartment units (and approximately 1% are accounts for the common areas of apartment buildings), approximately 6% are attached dwellings such as duplexes, row houses or townhouses, and 6.5% are mobile homes. Approximately 6% are separate accounts for sentinel lighting, nearly 2% are detached garages with separate accounts, and just over 1% are in the small grid housing category. The percentages for single detached homes and small grid housing are reduced by the removal of the accounts under 3,000 kWh/yr., which account for 21.5% of the accounts and are considered part of the seasonally-occupied housing category (cottages or cabins).
- The single-family detached and attached homes are divided into older and newer dwellings using 1980 as a dividing line. Approximately 46% of the dwellings were built before that year.
- Electricity is a relatively uncommon heating fuel in Yukon. In fact, in diesel grid communities, using electricity as the main heating fuel in a dwelling is not permitted. Consequently, only approximately 13% of dwellings in Yukon use electricity as their main heating fuel. The remaining 87% mainly use oil, propane or wood. The use of electricity for heating in the areas served by the hydro grid is rapidly increasing, as discussed in Section 5.

3.3 End Uses

Electricity use within each of the dwelling types noted above is defined on the basis of specific end uses. In this study, an end use is defined as, "the final application or final use to which energy is applied. End uses are the services of economic value to the users of energy."

A summary of the major Residential sector end uses used in this study is provided in Exhibit 5, together with a brief description of each.

Exhibit 5 Residential Electric End Uses

End Use	Description
Space heating	All space heating, including both central heating and supplementary heating
Ventilation and circulation	Primarily the furnace fan, but also includes the fan in heat recovery ventilators as well as kitchen and bathroom fans. Also includes pumps in hydronic heating systems
Domestic hot water (DHW)	Heating of water for DHW use. Does not include hydronic space heating
Indoor lighting	Interior lighting, excluding indoor holiday lighting
Outdoor lighting	Exterior lighting, excluding outdoor holiday lighting
Holiday lighting	Holiday lighting, including both indoor and outdoor
Cooking	Includes ranges, separate ovens and cook tops and microwave ovens
Refrigerator	
Freezer	
Dishwasher	
Clothes washer	
Clothes dryer	
Spa heaters and pumps	Includes both indoor and outdoor spas, both the heating systems and the pumps
Computer and peripherals	Computers, both desktop and laptop, printers, scanners, modems, faxes, PDA and cell phone chargers, security systems, etc.
Television	
Set-top boxes	Includes digital cable converters, satellite converters, and PVRs
Home entertainment electronics	Stereos, DVD players, VCRs, boom boxes, radios, video gaming systems
Block heaters & car warmers	Electric plug-in devices for pre-heating the engine block of a car for ease of starting, and for warming up the passenger compartment of the car. Also includes car battery warmers.
Heat tape, propane heaters, circulation pumps	Electric plug-in devices for preventing water lines from freezing, including both heat tape and circulation pumps, and devices for warming outdoor propane tanks so the propane will flow easily
Small Appliance & Other	There are hundreds of additional items within this category, each accounting for a fraction of a percent of household electricity use, e.g., hair dryers, doorbells, garage door openers, home medical equipment, electric lawnmowers, etc.

3.4 Average Electricity Use per Dwelling Unit

Exhibit 6 provides a profile of average electricity use within each of the dwelling types that were identified previously. The values shown in Exhibit 6 combine three factors:

- **Unit Energy Consumption (UEC).** This is the average amount of electricity that one appliance (e.g., a hot water tank) consumes annually in a given dwelling type.
- **Saturation.** This is the percentage of households within each dwelling type that have the given appliance. For example, in the case of a hot water tank, every household has one and, therefore, the saturation is 100%. However, for some appliances such as refrigerators or televisions, the saturation is often greater than 100%, as many households have more than one refrigerator or television.
- **Electric Fuel Share.** Several appliances, such as hot water tanks, clothes dryers, cooking ranges, etc., can operate on propane gas or other fuels as well as electricity. Electric fuel share, therefore, refers to the percentage of each appliance that operates with electricity.

A sample calculation is provided below for DHW use in pre-1980 single detached homes, as shown in Exhibit 6. The exhibits referenced below are contained in Appendix A, which accompanies this report.

Sample Calculation of Annual DHW Electricity Consumption for Pre-1980 Single Detached Non-electrically Heated Homes

UEC, see Exhibit A 2	3,453 kWh/yr.
Saturation, see Exhibit A 12	100%
Electric Fuel Share, see Exhibit A 13	79%[15]

Annual DHW Electricity Consumption = 3,453 x 100% x 79.4% = 2,742 kWh/yr.
(as shown in Exhibit 6.)

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[15] DHW electric share for these houses is lower than the overall DHW electric share found in the Yukon REEUS. This is because the electrically heated houses are assumed to have 100% electric DHW, and the remaining electric DHW share is distributed among the non-electrically heated houses.

Exhibit 6 Average Electricity Use per Dwelling Unit, (kWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	1,047	600	2,742	1,029	288	28	651	862	543	100
Pre-1980 non-electrically heated single detached homes	1,466	609	2,742	1,029	288	28	651	785	495	91
1980 & newer electrically heated single detached homes	12,075	100	3,453	1,029	288	28	716	784	494	91
Pre-1980 electrically heated single detached homes	14,856	100	3,453	1,029	288	28	716	715	450	83
1980 & newer non-electrically heated attached/row housing	669	462	2,164	698	189	14	434	669	422	63
Pre-1980 non-electrically heated attached/row housing	916	468	2,164	698	189	14	434	592	373	56
1980 & newer electrically heated attached/row housing	6,602	100	2,724	698	189	14	478	609	384	58
Pre-1980 electrically heated attached/row housing	9,045	100	2,724	698	189	14	478	539	340	51
Non-electrically heated apartment units	516	357	1,181	497	54	6	373	524	330	42
Non-electrically heated apartment common areas	1,268	4,370	-	6,067	657	72	-	-	-	-
Electrically heated apartment units	5,719	50	1,483	499	54	6	411	526	332	42
Electrically heated apartment common areas	13,935	611	-	6,101	660	72	-	-	-	-
Non-electrically heated mobile/other	887	489	2,177	702	190	14	444	524	330	50
Electrically heated mobile/other	9,345	100	2,724	698	189	14	478	521	328	49
Small diesel grid housing	676	443	2,746	989	276	27	636	687	433	80
Seasonal housing	34	15	242	174	49	-	56	54	34	6
Residential garages	487	363	-	601	168	-	-	-	-	-
Sentinel Lighting	-	-	-	-	643	-	-	-	-	-
Weighted Average	1,714	389	1,789	736	224	16	416	519	327	57

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total
1980 & newer non-electrically heated single detached homes	81	1,091	1,466	1,025	412	260	106	282	71	186	12,870
Pre-1980 non-electrically heated single detached homes	74	995	1,336	934	376	237	106	257	65	186	12,748
1980 & newer electrically heated single detached homes	73	1,024	1,505	933	375	237	106	257	65	186	23,819
Pre-1980 electrically heated single detached homes	67	934	1,372	850	342	216	106	234	59	186	26,083
1980 & newer non-electrically heated attached/row housing	51	692	1,395	975	392	248	72	269	68	126	10,072
Pre-1980 non-electrically heated attached/row housing	45	613	1,235	863	347	219	72	238	60	126	9,723
1980 & newer electrically heated attached/row housing	47	650	1,432	888	357	226	72	244	62	126	15,959
Pre-1980 electrically heated attached/row housing	41	575	1,267	786	316	200	72	216	54	126	17,832
Non-electrically heated apartment units	17	231	-	755	304	192	61	-	-	107	5,544
Non-electrically heated apartment common areas	208	2,817	2,168	-	-	-	-	2,539	639	-	20,805
Electrically heated apartment units	17	239	-	758	305	193	61	-	-	107	10,803
Electrically heated apartment common areas	209	2,917	2,447	-	-	-	-	2,553	643	-	30,149
Non-electrically heated mobile/other	40	545	558	763	307	194	72	210	53	127	8,676
Electrically heated mobile/other	40	555	612	758	305	193	72	209	53	126	17,368
Small diesel grid housing	64	875	1,195	818	329	208	101	225	57	179	11,045
Seasonal housing	5	69	278	64	26	16	18	-	-	32	1,173
Residential garages	-	-	-	-	-	-	-	228	57	1,169	3,074
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	643
Weighted Average	46	631	863	650	261	165	69	186	47	142	9,247

3.5 Summary of Residential Base Year Electricity Use

This section combines the data on average annual electricity use by dwelling type, shown in the preceding exhibit, with data on the number of each dwelling type to produce a summary of the total electricity use in Yukon's Residential sector in the Base Year. The results are measured at the customer's point-of-use and do not include line losses; they are presented in five separate exhibits:

- Exhibit 7 presents the results in tabular form by dwelling type and end use
- Exhibit 8, Exhibit 9, and Exhibit 10 present the model results graphically by dwelling type, by supply type and government versus non-government, and by end use, respectively
- Exhibit 11 presents the model results as a series of stacked bars, showing the percentage consumed by end use for each dwelling type.

Additional highlights are provided below.

By Dwelling Type

Single detached dwellings account for the majority of residential electricity use in Yukon, with approximately 72% of residential electricity consumed. Apartment buildings, including both the suites and common areas, account for the next largest share, using 9% of residential electricity. Attached houses (duplexes, row houses, and townhouses) and mobile homes each account for 7% of residential electricity.

Seasonal houses (using less than 3,000 kWh/yr. each) account for nearly 3% of total residential electricity consumption. The dwellings in the Small Grid Housing category account for just over 1% of residential electricity. Residential garages also consume approximately 1% of residential electricity. Sentinel lighting uses less than 0.5% of residential electricity.

By Supply Type and Government versus Non-government Accounts

The accounts connected to the hydro grid consume approximately 94% of residential electricity. Accounts connected to large diesel grids consume approximately 4.5% of residential electricity. Accounts connected to small diesel grids consume less than 1% of residential electricity, as do accounts in the fly-in community of Old Crow.

Government of Yukon accounts consume less than 2%[16] of residential electricity, with non-government accounts consuming the other 98%.

By End Use

HVAC accounts for 23% of consumption, with 19% of that being electric space heating and the remainder being fans and pumps, including furnace fans, boiler circulation pumps, HRV fans, and bathroom and kitchen exhaust.

Domestic appliances (white goods) consume approximately 22% of total residential electricity. Of this, clothes dryers account for 7% and refrigerators for 6%. Cooking appliances and freezers each consume approximately 4%. Dishwashers and clothes washers consume approximately

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[16] Other categories of rental customers will be considered in the Achievable Potential chapter (Section 10).

1% each, but this does not include the associated DHW consumption if DHW is heated electrically.

Domestic water heating accounts for approximately 19% of residential electricity consumption.

Household electronics consume approximately 12% of residential electricity, including 7% by computers and their peripherals, 3% by televisions, 2% by the various set-top boxes associated with televisions, and 1% by other home entertainment electronics.

Indoor, outdoor, and holiday lighting together account for 11% of residential electricity consumption; 8% of this is indoor lighting and 2% is outdoor lighting. Holiday lighting is well under 1%.

Other end uses account for 13% of residential electricity consumption. Of this, 9% is consumed by spa heaters and pumps and 2% is consumed by block heaters and car warmers.

By Dwelling Type and End Use

The last exhibit in this section highlights the differences among dwelling types. In general, for example, attached dwellings show a lower percentage of consumption for HVAC and a higher percentage for electronics and appliances than single detached houses.

The exhibit also highlights how much more of the electricity is used for HVAC in an electrically heated dwelling.

Finally, in apartment buildings, the common area consumption is dominated by lighting, while the consumption in the suites is dominated by appliances and electronics. Most of the "other" end uses in an apartment building, such as spas or block heaters, are likely in the common areas of the building.

Data Manager – Final Edition

As part of this report, an Excel application called Data Manager is provided. This Excel workbook includes all the exhibits that were produced using Excel for Chapters 3, 4, 5, 6, 7, 8 and 10, and the corresponding Appendices. It also has the ability to produce charts and tables looking at the data filtered and segmented in other ways. For example:

- The user can produce a pie chart of electricity consumption by end use for an individual dwelling type of interest, such as the electrically heated older detached house.
- The user can produce a column chart showing the electricity consumption for kitchen and laundry appliances in each of several dwelling types, with each dwelling type as a separate column and the different appliance consumption values shown stacked on top of each other.
- The user can produce a line chart showing consumption for a particular dwelling type by year under both the reference case and the economic potential.
- The user can produce a column chart showing the savings of individual measures for a particular type of dwelling, broken up by supply system.

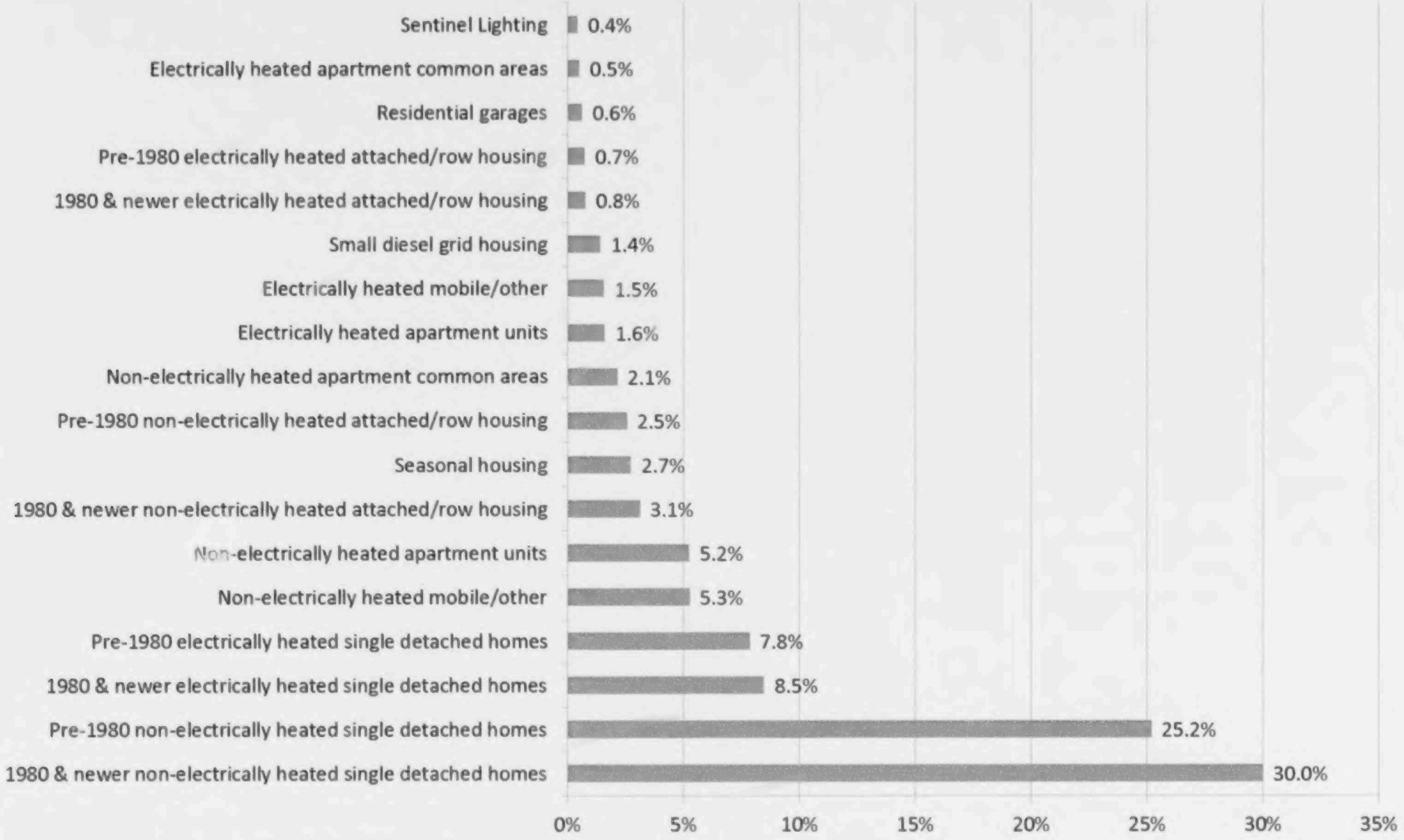
Data Manager has a user interface designed for someone with basic knowledge of Excel.

Exhibit 7 Electricity Consumption by End Use and Dwelling Type in the Base Year (2010), (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	3,566	2,045	9,337	3,504	979	95	2,216	2,934	1,848	340
Pre-1980 non-electrically heated single detached homes	4,228	1,755	7,907	2,968	829	81	1,877	2,265	1,426	263
1980 & newer electrically heated single detached homes	6,267	52	1,792	534	149	15	372	407	256	47
Pre-1980 electrically heated single detached homes	6,522	44	1,516	452	126	12	315	314	198	36
1980 & newer non-electrically heated attached/row housing	302	208	976	315	85	6	196	302	190	29
Pre-1980 non-electrically heated attached/row housing	349	179	825	266	72	5	165	226	142	21
1980 & newer electrically heated attached/row housing	456	7	188	48	13	1	33	42	26	4
Pre-1980 electrically heated attached/row housing	534	6	161	41	11	1	28	32	20	3
Non-electrically heated apartment units	710	491	1,624	683	74	8	513	721	454	58
Non-electrically heated apartment common areas	190	654	-	908	98	11	-	-	-	-
Electrically heated apartment units	1,230	11	319	107	12	1	88	113	71	9
Electrically heated apartment common areas	334	15	-	146	16	2	-	-	-	-
Non-electrically heated mobile/other	784	432	1,924	621	168	13	392	463	292	44
Electrically heated mobile/other	1,205	13	351	90	24	2	62	67	42	6
Small diesel grid housing	124	81	504	182	51	5	117	126	79	15
Seasonal housing	117	50	820	591	165	-	190	183	115	21
Residential garages	138	103	-	171	48	-	-	-	-	-
Sentinel Lighting	-	-	-	-	609	-	-	-	-	-
Grand Total	27,056	6,145	28,244	11,627	3,530	258	6,563	8,195	5,160	896

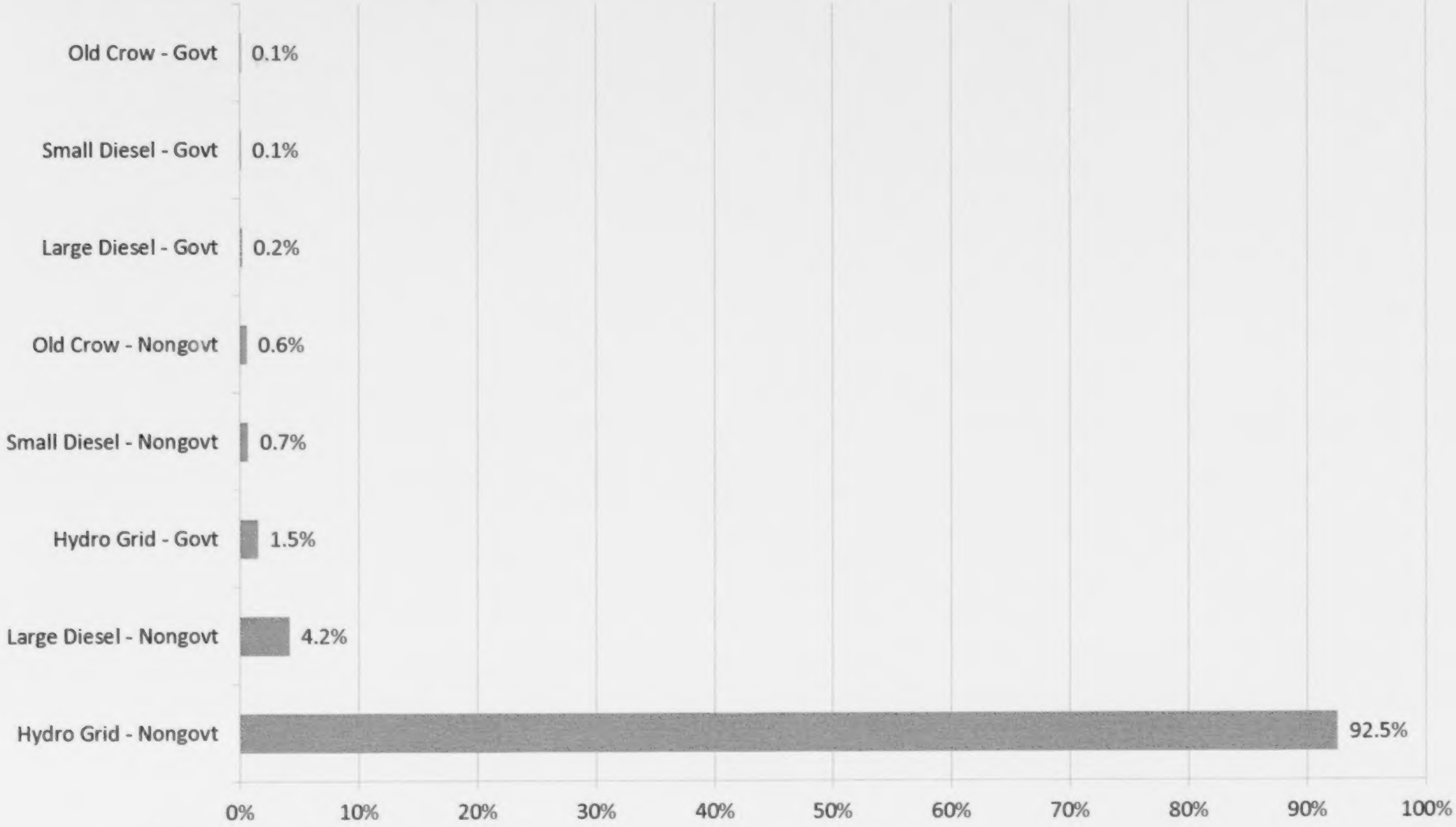
Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
1980 & newer non-electrically heated single detached homes	275	3,717	4,993	3,490	1,404	887	359	961	242	634	43,826	30%
Pre-1980 non-electrically heated single detached homes	212	2,869	3,854	2,694	1,084	684	304	742	187	537	36,766	25%
1980 & newer electrically heated single detached homes	38	532	781	484	195	123	55	133	34	97	12,362	8%
Pre-1980 electrically heated single detached homes	29	410	602	373	150	95	46	103	26	82	11,450	8%
1980 & newer non-electrically heated attached/row housing	23	312	629	440	177	112	32	121	30	57	4,542	3%
Pre-1980 non-electrically heated attached/row housing	17	234	471	329	132	84	27	91	23	48	3,707	3%
1980 & newer electrically heated attached/row housing	3	45	99	61	25	16	5	17	4	9	1,101	1%
Pre-1980 electrically heated attached/row housing	2	34	75	46	19	12	4	13	3	7	1,052	1%
Non-electrically heated apartment units	23	317	-	1,038	418	264	83	-	-	147	7,626	5%
Non-electrically heated apartment common areas	31	422	324	-	-	-	-	380	96	-	3,114	2%
Electrically heated apartment units	4	51	-	163	66	41	13	-	-	23	2,323	2%
Electrically heated apartment common areas	5	70	59	-	-	-	-	61	15	-	724	0.5%
Non-electrically heated mobile/other	35	481	493	675	271	171	64	186	47	112	7,668	5%
Electrically heated mobile/other	5	72	79	98	39	25	9	27	7	16	2,241	2%
Small diesel grid housing	12	161	219	150	60	38	19	41	10	33	2,029	1%
Seasonal housing	17	233	942	218	88	56	61	-	-	107	3,973	3%
Residential garages	-	-	-	-	-	-	-	65	16	332	873	1%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	609	0.4%
Grand Total	733	9,959	13,620	10,260	4,128	2,606	1,082	2,940	740	2,241	145,984	100%

Exhibit 8 Distribution of Electricity Consumption, by Dwelling Type in the Base Year (2010)



Totals may not add to 100% due to rounding.

Exhibit 9 Distribution of Electricity Consumption, by Supply Type and Government versus Non-government in the Base Year (2010)



Totals may not add to 100% due to rounding.

Exhibit 10 Distribution of Electricity Consumption, by End Use in the Base Year (2010)

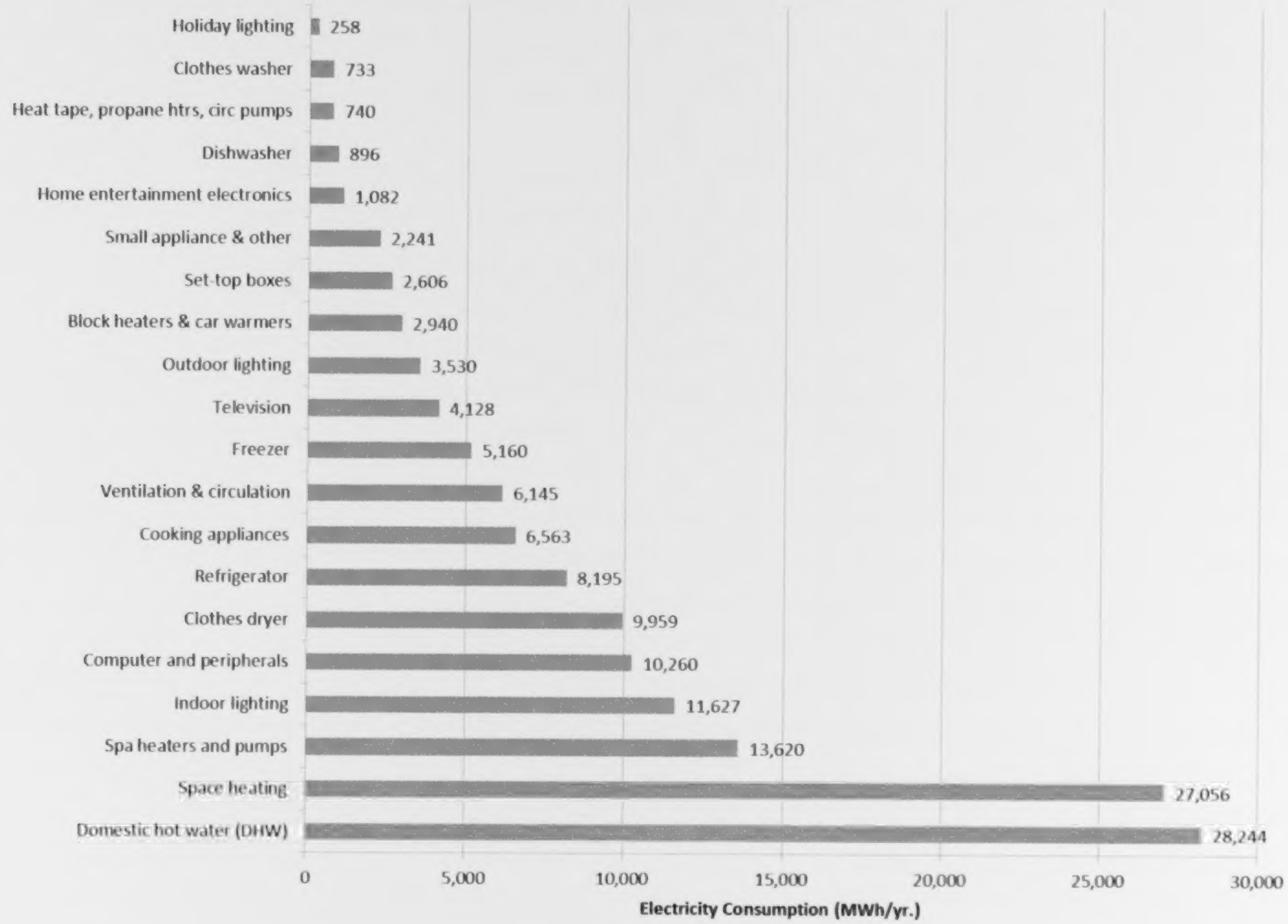
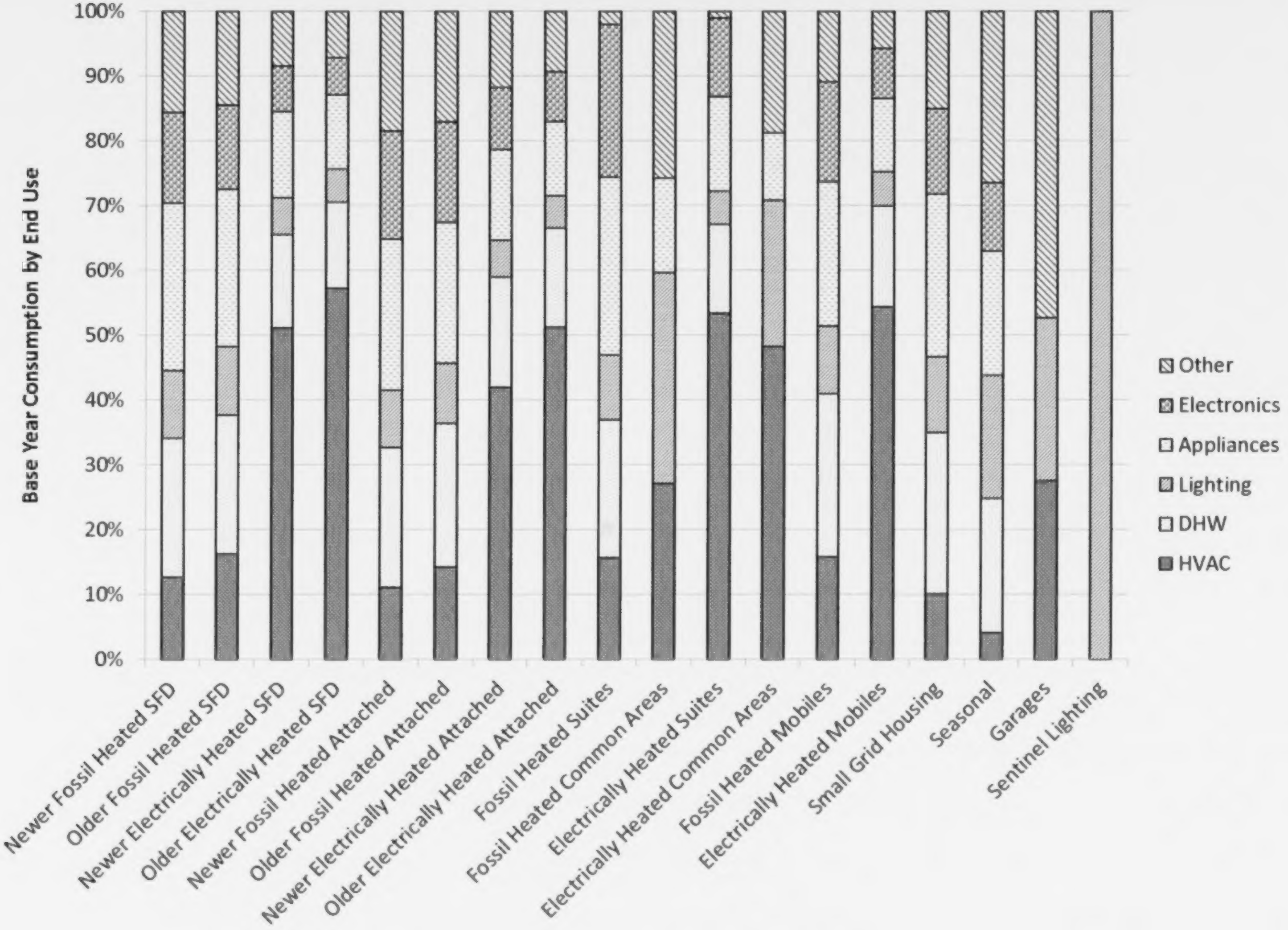


Exhibit 11 Distribution of Electricity Consumption, by Dwelling Type and End Use in the Base Year (2010)



4 Base Year (2010) Electric Peak Load

4.1 Introduction

This section provides a profile of the Base Year electric peak load for Yukon's Residential sector. The discussion is organized into the following sub sections:

- Peak period definitions
- Methodology
- Summary of results.

Additional details are provided in Appendix B.

4.2 Peak Period Definitions

Based on discussions with utility personnel, the following three peak period definitions were selected for inclusion in this study:

Peak Period 1: Annual System Peak Hour – This has traditionally been the hour ending at 6 pm on a day in December; it is highly correlated with the coldest day of the year when occurring in December, although it has sometimes occurred in January.

Peak Period 2: Annual Weekday System Evening Peak Period – The 4-8 pm period on the coldest four days of the year when occurring in December or January (total 16 hours).

Peak Period 3: Annual Weekday System Morning Peak Period – The 7-9 am period on the 10 coldest days of the year when occurring in December or January (total 20 hours).

4.3 Methodology

The electric peak load profile converts the annual electric energy use (MWh) presented in Section 3 to hourly demand (MW). Development of the electric peak load estimates employs four specific factors, which are described below and shown graphically in Exhibit 12.

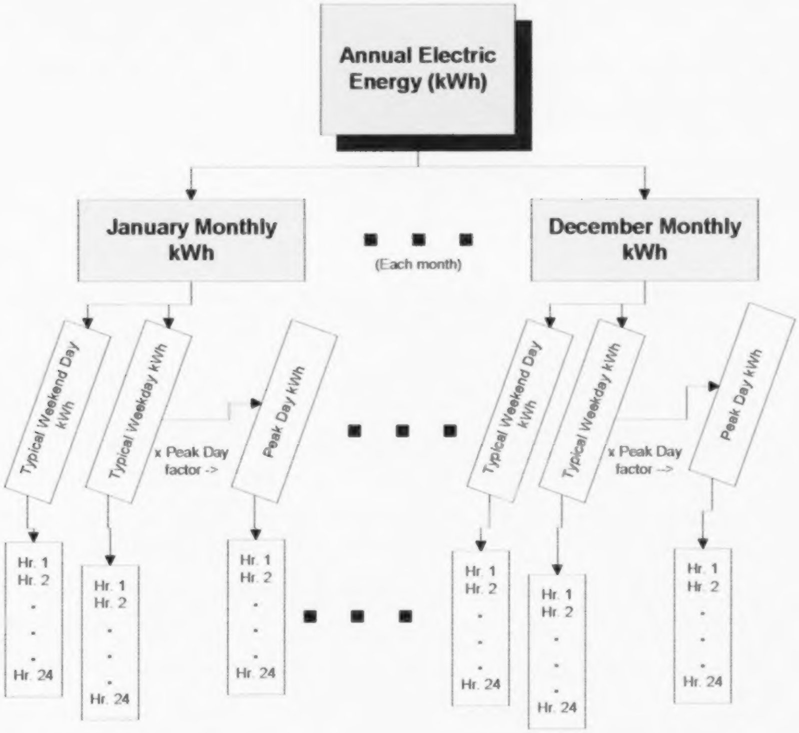
- **Monthly Usage Allocation Factor:** This factor represents the percent of annual electric energy usage that is allocated to each month. This set of monthly fractions (percentages) reflects the seasonality of the load shape, whether a facility, process or end use, and is dictated by weather or other seasonal factors. In decreasing order of priority, this allocation factor can be obtained from either:
    - Monthly consumption statistics from end-use load studies
    - Monthly seasonal sales (preferably weather normalized) obtained by subtracting a "base" month from winter and summer heating and cooling months, or
    - Heating or cooling degree days applied to an appropriate base.

- **Weekend to Weekday Factor:** This factor is a ratio that describes the relationship between weekends and weekdays, reflecting the degree of weekend activity inherent in the facility or end use. This may vary by month or season. Based on this ratio, the average electric energy per day type can be computed from the corresponding monthly electric energy.

- **Peak Day Factor:** This factor reflects the degree of daily weather sensitivity associated with the load shape, particularly heating or cooling; it compares a peak (e.g., hottest or coldest) day to a typical weekday in that month.

- **Per Unit Hourly Factor:** This factor reflects the operating hours of the residential electric equipment or end uses among different hours of the day for each day type (weekday, weekend day, peak day) and for each month. For example, for lighting, this would be affected by time of day and season (affected by daylight).

Exhibit 12 Overview of Peak Load Profile Methodology


Annual Electric Energy (kWh)
January Monthly kWh
(Each month)
December Monthly kWh
Typical Weekend Day kWh
Typical Weekday kWh
x Peak Day factor ->
Peak Day kWh
Typical Weekend Day kWh
Typical Weekday kWh
x Peak Day factor ->
Peak Day kWh
Hr. 1
Hr. 2
Hr. 24

4.4 Summary of Results

The three factors (sets of ratios) defined above provided the basis for converting the annual residential electricity use presented in Section 3 to aggregate peak loads in each of the three peak periods identified for this study.

Exhibit 13 presents the results for the Residential sector Base Year. The results are presented for the total Yukon service territory, by dwelling type. In each case, the results show the contribution of Residential sector demand that is coincident with the total Yukon demand in each of the three peak periods selected for this study.

Exhibit 13 Residential Sector Base Year (2011) Aggregate Peak Demand by Peak Period (MW)[17]

Dwelling Types	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	24.8	23.2	17.4
Apartments	3.4	3.3	2.0
Attached/Row Houses	2.3	2.2	1.6
Mobile/Other	2.3	2.2	1.7
Seasonal & Garage	1.0	0.9	0.7
Small Grid Housing	0.3	0.4	0.3
Sentinel Lighting	0.1	0.1	0.1
Grand Total	34.3	32.4	23.9

Exhibit 14, Exhibit 15 and Exhibit 16 show the contribution, by end use, to the residential component of the peak demand, for the Annual Peak Hour, the Evening Peak, and the Morning Peak, respectively. Some key observations may be made:

- Space heating is the largest residential component of peak demand for Peak Periods 1 and 2 and is the second largest in the Morning Peak. As shown in the previous section, space heating is one of the largest end uses in terms of annual electrical consumption. It also tends to be concentrated in the winter when the Yukon system peaks.

- Cooking appliances are the second largest residential component of the Annual Peak Hour demand and are in the top six for the other two peak periods. This is largely because cooking is so concentrated during the evening and morning system peak periods.

- Indoor lighting is the second largest residential component of the Evening Peak and is in the top five for the other two peak periods. As shown in the previous section, indoor lighting is a large end use in terms of annual electrical consumption. It also tends to be used heavily during the evening and morning hours when the Yukon system peaks.

- Domestic hot water is the largest residential component of the Morning Peak and is in the top five for the other two peak periods. It is a large end use and is heavily used during the morning hours when the Morning Peak occurs.

- Clothes dryers are the fourth largest residential contributor to the Annual Peak Hour demand, but are smaller components of both of the other peak periods. The peak use of clothes dryers coincides fairly closely with the system peak hour.

- Block heaters and car warmers make the fourth largest residential contribution to the Evening Peak, but are not as significant a contributor to the Annual Peak Hour demand and do not contribute significantly to the morning peak at all. Block heaters and car warmers account for only an estimated 2% of annual residential electrical consumption, but they are highly coincident with the winter evening hours when Peak Periods 1 and 2 occur.

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[17] For readability, the dwelling types are aggregated into larger categories in this exhibit than in other parts of the report. The more detailed breakdown is available in the Data Manager workbook, submitted at the same time as this report.

Exhibit 14 Contribution by End Use to Residential Aggregate Peak Demand, Annual Peak Hour (%)

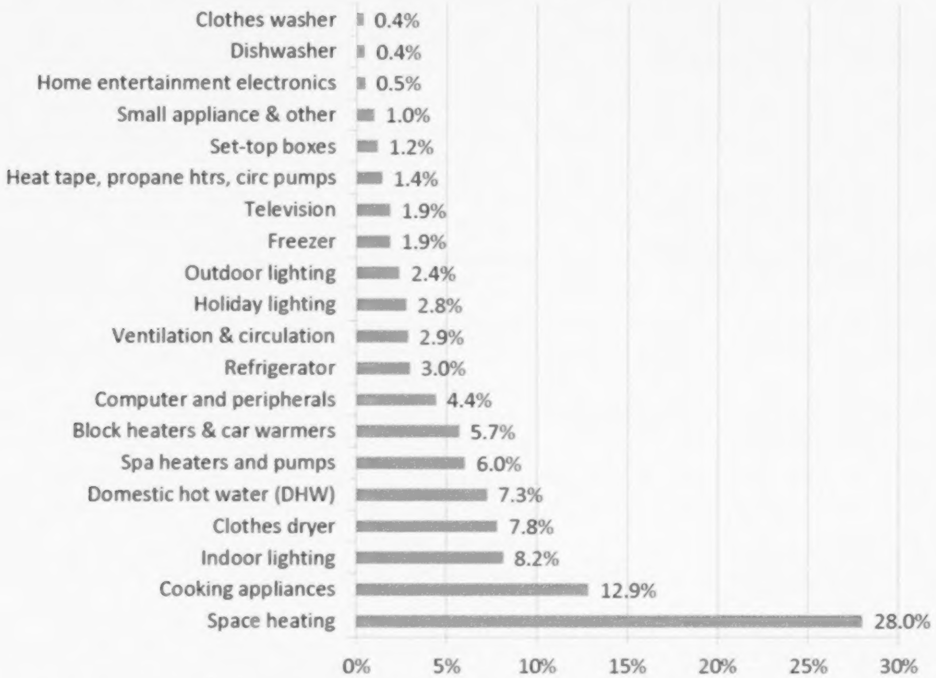


Exhibit 15 Contribution by End Use to Residential Aggregate Peak Demand, Evening Peak (%)

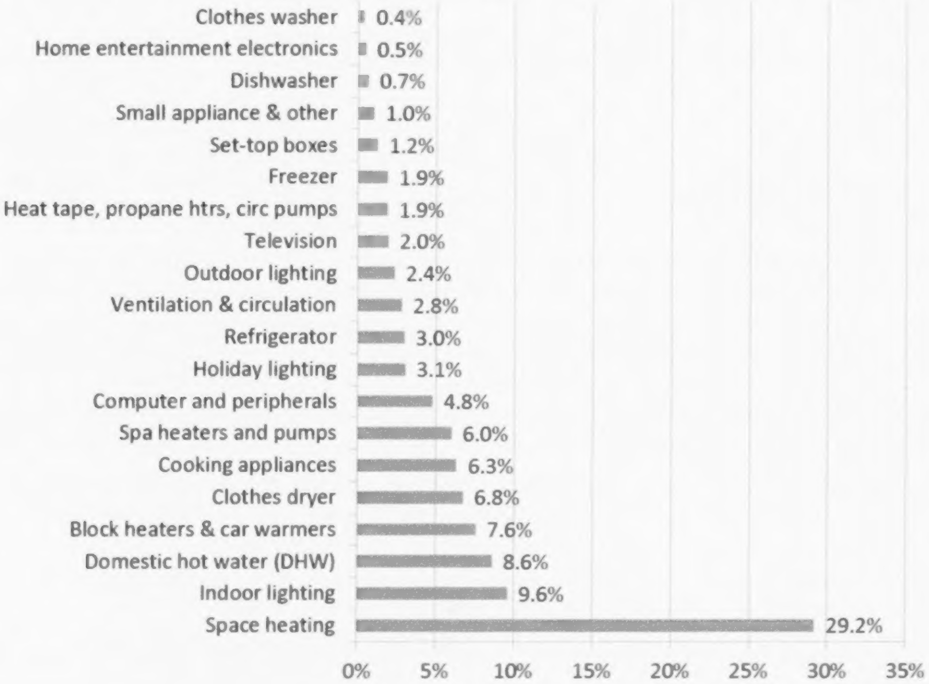
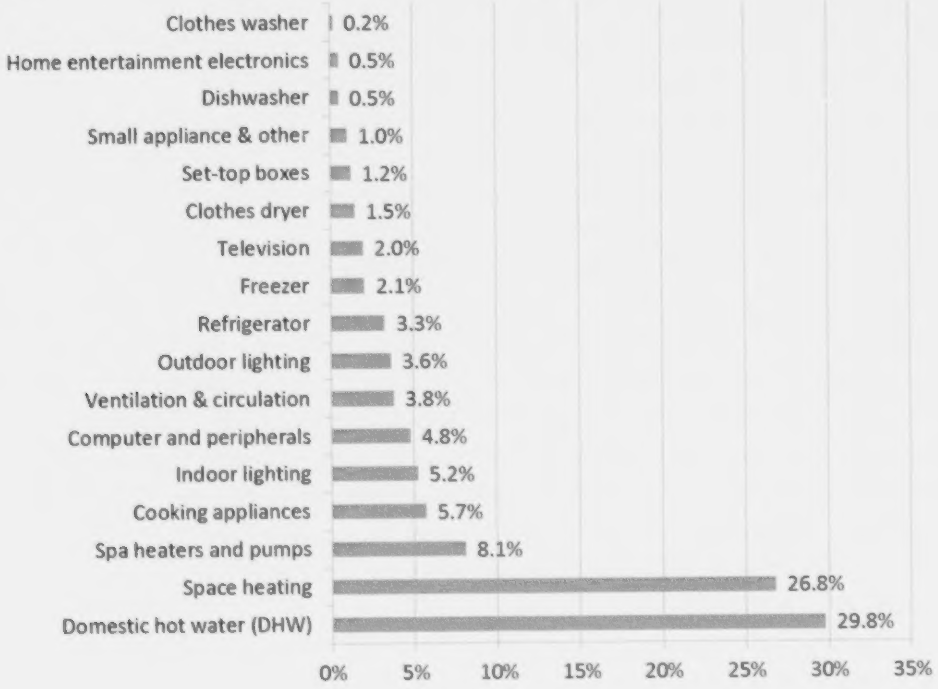


Exhibit 16 Contribution by End Use to Residential Aggregate Peak Demand, Morning Peak (%)



Additional detail is provided in Appendix B.

5 Reference Case Electric Energy Forecast

5.1 Introduction

This section presents the Residential sector Reference Case for the study period (2010 to 2030). The Reference Case estimates the expected level of electricity consumption that would occur over the study period in the absence of new utility-based DSM initiatives. The Reference Case, therefore, provides the point of comparison for the calculation of electricity saving opportunities associated with each of the scenarios that are assessed within this study.

The Reference Case discussion is presented within the following sub sections:

- Methodology
- Summary of model results.

5.2 Methodology

Development of the Reference Case involved the following six steps:

Step 1: The growth in the number of residential dwellings was estimated for each type of dwelling.

Step 2: The net space heating and cooling loads for each new dwelling type were estimated. New dwellings are those built after the base year, 2010.

Step 3: Naturally-occurring changes in net space heating and cooling loads were estimated for existing dwelling types.

Step 4: Naturally-occurring changes in annual electricity use were estimated for the evolving stock of major residential appliances.

Step 5: Future appliance saturation trends were estimated for each dwelling type.

Step 6: Changes in electricity share for each appliance were estimated for each dwelling type.

Exhibit 17 shows the estimated number of residential units in each milestone period, by dwelling type. The estimates shown are derived from YEC's 20-Year Resource Plan – 2011.

Higher rates of growth have been applied to both the attached houses and the apartments, compared to the rate of growth for single detached houses. The attached houses are assumed to increase in number 1.5 times as fast as the single detached houses, and the apartments are assumed to increase in number three times as fast as single detached houses, with the overall growth rate calibrated to the expected increase in number of accounts assumed in the load forecast.[18] These ratios are approximately consistent with the ratios in recent construction in Yukon, and are similar to those found in other parts of Canada.

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[18] Note that growth in number of accounts does not translate directly into growth in consumption because the dwelling types have different overall consumption and different mixes of end uses.

Growth rates for electrically heated dwellings are assumed to be much larger than for non-electrically heated dwellings, based on both recent and planned construction.[19] For detached dwellings, construction is expected to result in approximately equal numbers of electrically and non-electrically heated new dwellings during the study period. For attached houses (including both row/townhouses and apartments), 75% of the new dwellings during the study period are expected to be electrically heated. This applies only to the hydro grid areas of the territory, not to areas supplied by diesel grids.

Exhibit 17 Residential Accounts by Dwelling Type and Milestone Year

Dwelling Types	Number of Dwellings			
	2015	2020	2025	2030
1980 & newer non-electrically heated single detached homes	3,724	4,021	4,291	4,535
Pre-1980 non-electrically heated single detached homes	2,884	2,884	2,884	2,884
1980 & newer electrically heated single detached homes	769	1,044	1,336	1,635
Pre-1980 electrically heated single detached homes	439	439	439	439
1980 & newer non-electrically heated attached/row housing	495	535	573	606
Pre-1980 non-electrically heated attached/row housing	381	381	381	381
1980 & newer electrically heated attached/row housing	128	202	291	392
Pre-1980 electrically heated attached/row housing	59	59	59	59
Non-electrically heated apartment units	1,501	1,622	1,736	1,841
Non-electrically heated apartment common areas	163	176	188	200
Electrically heated apartment units	400	697	1,133	1,731
Electrically heated apartment common areas	44	76	123	187
Non-electrically heated mobile/other	927	968	1,005	1,038
Electrically heated mobile/other	163	200	239	280
Small diesel grid housing	189	195	202	209
Seasonal housing	3,558	3,717	3,863	3,995
Residential garages	298	312	324	334
Sentinel Lighting	990	1,031	1,068	1,101
Grand Total	17,114	18,561	20,134	21,849

A detailed discussion of the methodology employed in each of the remaining steps is provided in Appendix C.

5.3 Summary of Results

This section presents the results of the model runs for the entire study period. The results are measured at the customer's point-of-use and do not include line losses. They are presented in four exhibits:

- Exhibit 18 presents the model results in tabular form, by dwelling type, end use and milestone year

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[19] The primary source of information was local utility knowledge of planned subdivisions and commercial construction. Yukon utility personnel are in regular contact with the construction industry and with Yukon Housing Corporation, to maintain up-to-date information on expected new loads on the system.

- Exhibit 19 presents the model results for 2030 by dwelling type
- Exhibit 20 presents the model results for 2030 by by supply type and government versus non-government
- Exhibit 21 presents the model results for 2030 by end use
- Exhibit 22 shows the evolving relative contribution of different summary end uses towards the total consumption in different dwelling types.

Selected highlights of electricity use in 2030 are provided below.

By Dwelling Type

Single detached dwellings will continue to account for the majority of residential electricity use in Yukon, but will decline to approximately 65% of residential electricity consumed in 2030. Apartment and condo buildings, including both the suites and the common areas, are expected to rise to 17% of residential electricity by 2030. Attached houses (duplexes, row houses, and townhouses), are expected to remain at approximately 7% of residential electricity. Mobile homes will also consume approximately 6% of residential electricity.

Seasonal houses are expected to use approximately 2% of residential electricity. The dwellings in the Small Grid Housing category (accounts connected to small diesel grids and the Old Crow system) will continue to account for approximately 1% of residential electricity by 2030. Residential garages are expected to consume just over 0.5% of residential electricity. Sentinel lighting is expected to use less than 0.5% of residential electricity.

By Supply Type and Government versus Non-government Accounts

The accounts connected to the hydro grid are expected to consume approximately 96% of residential electricity in 2030. Accounts connected to large diesel grids will consume approximately 3% of residential electricity. Accounts connected to small diesel grids are expected to consume less than 1% of residential electricity, as will accounts in the fly-in community of Old Crow.

Government of Yukon accounts are expected to consume approximately 2% of residential electricity in 2030, with non-government accounts consuming the other 98%.

By End Use

HVAC is expected to account for 28% of consumption in 2030, a modest decline from the current level; 24% of that will be electric space heating and the remainder will be fans and pumps, including furnace fans, boiler circulation pumps, HRV fans, and bathroom and kitchen exhaust.

Household electronics are expected to consume approximately 20% of residential electricity in 2030, which is a substantial increase. Of this, approximately 10% will be used by computers and their peripherals, 5% by various home entertainment electronics, 3% by televisions, and 2% by the various set-top boxes associated with televisions. The most substantial growth in this broad category is in the general home entertainment electronics. Much of this significant increase represents the introduction of unknown new end uses in the future.

Domestic appliances (white goods) are expected to consume approximately 17% of residential electricity altogether, by 2030, a modest decline from current levels. Of this, clothes dryers are expected to account for 6% and refrigerators for 4%. Cooking appliances and freezers are each expected to consume approximately 3%. Dishwashers and clothes washers will consume less than 1% each, but this does not include the associated DHW consumption if DHW is heated electrically.

Domestic water heating is expected to account for approximately 13% of residential electricity consumption by 2030, a substantial decline from current values. This decrease is expected to occur primarily because of improved efficiency of devices in the home that use hot water, such as dishwashers, clothes washers, showerheads and faucet aerators.

Indoor, outdoor, and holiday lighting together are expected to account for 7% of residential electricity consumption in 2030, a substantial decrease from the present level. Indoor lighting accounts for 5% of expected 2030 consumption and outdoor lighting accounts for 1%. The holiday lighting portion becomes vanishingly small by 2030.

Other end uses are expected to account for 15% of residential electricity consumption in 2030, a substantial increase. Of this, 3% is expected to be consumed by spa heaters and pumps, a substantial decrease from current levels. Block heaters and car warmers are expected to consume 2%, largely the same percentage as presently. The remaining 9% is expected to be consumed by the small appliances and other category. The latter is another end use with many unknowns, increasing to represent the introduction of new end uses.

By Dwelling Type and End Use

The last exhibit in this section shows the trends in consumption by major end-use groupings. The following key observations can be made:

- Heating, ventilation and circulation, and cooling are expected to maintain a relatively stable share of residential electricity consumption between now and 2030.
- DHW will account for a moderately reduced share of residential electricity consumption, largely because of reduced consumption in dishwashers, clothes washers and low-flow fixtures.
- Lighting is expected to account for a steadily diminishing share of residential electricity consumption between now and 2030, even without new DSM intervention, largely because of the growing use of compact fluorescent lamps and LED holiday strings.
- The overall consumption of appliances will account for a modestly reduced share of consumption, because the forecast increase in the number of appliances per home will likely be more than cancelled out by gains in efficiency.
- Electronics in the home, including computers, televisions and set-top boxes, and other electronics, are expected to account for an increasing share of residential consumption. Even though some of these devices are becoming more efficient, their increasing numbers will more than cancel out any efficiency gains.
- Past experience suggests that electricity consumption per household remains remarkably stable over long periods. As more efficient equipment is introduced for some of the older end uses, new uses for electricity tend to emerge. This is reflected in the increase in consumption for "other" between now and 2030.
- The exhibit also permits comparisons of end-use consumption proportions from one dwelling type to another. These patterns are expected to remain relatively consistent through the study period.

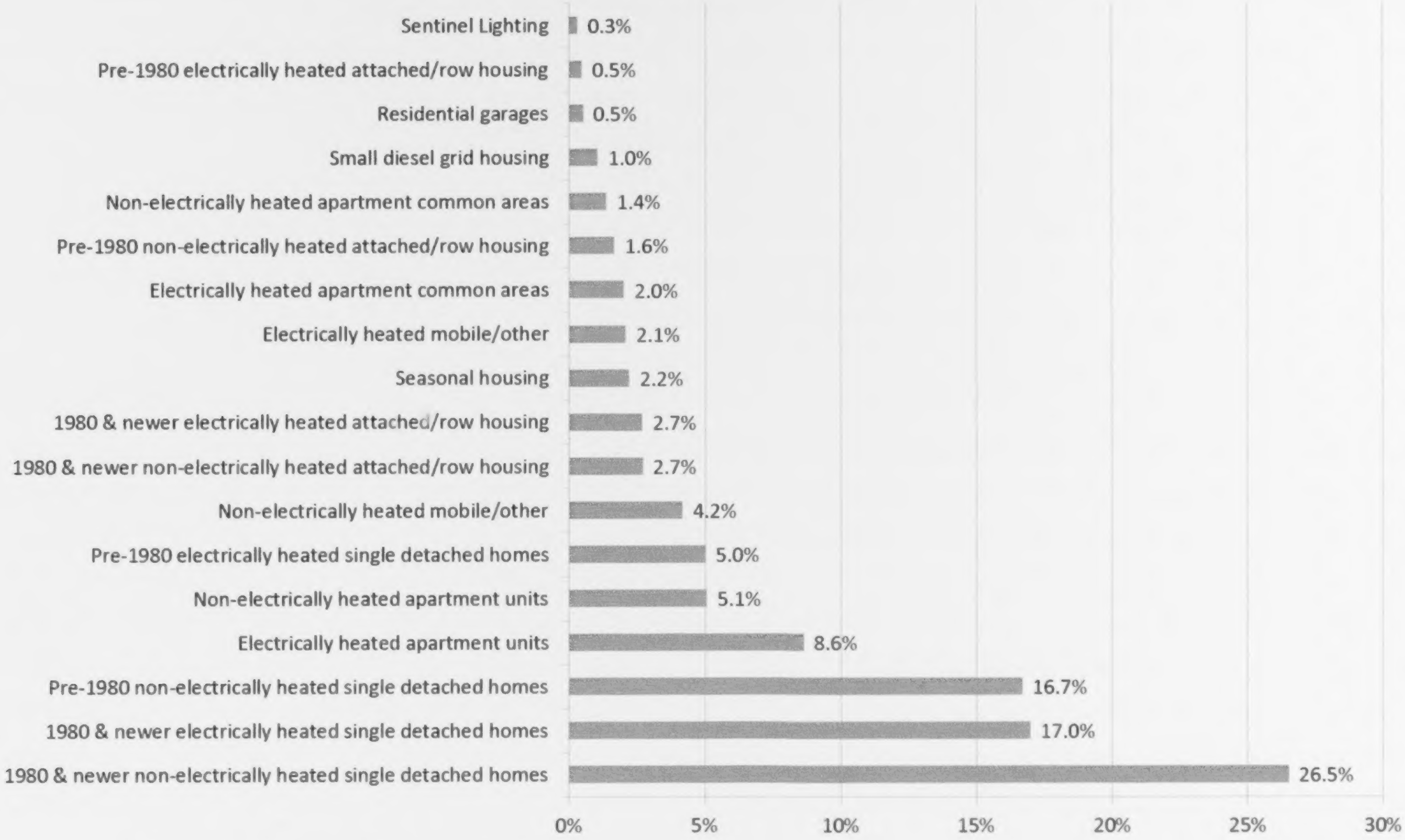
Exhibit 18 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year (MWh/yr.)

Dwelling Types	Milestone Years	HVAC	Appliances	Electronics	DHW	Other	Lighting	TOTAL
Single Detached House	2010	24,479	23,194	12,428	20,552	14,007	9,744	104,403
	2015	27,942	23,657	15,590	20,520	13,193	9,772	110,674
	2020	31,696	24,843	19,436	20,511	12,845	9,697	119,029
	2025	35,609	26,330	23,788	20,975	16,096	9,503	132,301
	2030	39,582	28,003	29,950	21,404	22,968	9,185	151,092
Apartment/Condo Suites and Common Areas	2010	3,634	2,951	2,087	1,943	1,106	2,066	13,786
	2015	5,185	2,647	2,879	2,142	1,345	2,246	16,444
	2020	7,542	3,074	4,033	2,465	1,786	2,464	21,363
	2025	10,906	3,707	5,627	2,988	2,777	2,705	28,711
	2030	15,445	4,559	8,129	3,691	4,764	2,943	39,531
Attached Dwelling	2010	2,040	2,130	1,521	2,149	1,697	865	10,403
	2015	2,469	2,238	1,942	2,203	1,600	879	11,331
	2020	3,000	2,394	2,470	2,284	1,533	887	12,568
	2025	3,624	2,634	3,078	2,441	1,897	885	14,560
	2030	4,330	2,901	3,931	2,620	2,693	870	17,345
Mobile	2010	2,435	1,962	1,352	2,276	966	918	9,908
	2015	2,777	1,933	1,684	2,267	973	919	10,553
	2020	3,126	2,011	2,083	2,262	1,041	911	11,435
	2025	3,477	2,116	2,524	2,309	1,374	893	12,693
	2030	3,825	2,238	3,137	2,352	2,021	863	14,436
Garages and Seasonal Housing	2010	408	760	421	820	1,462	975	4,846
	2015	428	757	529	797	1,387	956	4,853
	2020	446	772	679	772	1,356	927	4,952
	2025	462	794	878	763	1,624	889	5,410
	2030	478	820	1,189	752	2,155	843	6,237
Small Grid Housing	2010	206	510	267	504	304	237	2,029
	2015	213	507	322	483	274	228	2,027
	2020	221	512	389	463	256	218	2,058
	2025	229	525	465	455	306	207	2,187
	2030	238	543	579	449	416	195	2,421
Sentinel Lighting	2010	-	-	-	-	-	609	609
	2015	-	-	-	-	-	623	623
	2020	-	-	-	-	-	634	634
	2025	-	-	-	-	-	657	657
	2030	-	-	-	-	-	678	678
TOTAL	2010	33,201	31,506	18,076	28,244	19,542	15,414	145,984
	2015	39,013	31,739	22,946	28,412	18,771	15,623	156,505
	2020	46,031	33,606	29,092	28,756	18,817	15,738	172,039
	2025	54,308	36,107	36,360	29,931	24,074	15,739	196,519
	2030	63,898	39,064	46,915	31,268	35,017	15,577	231,739

Notes:

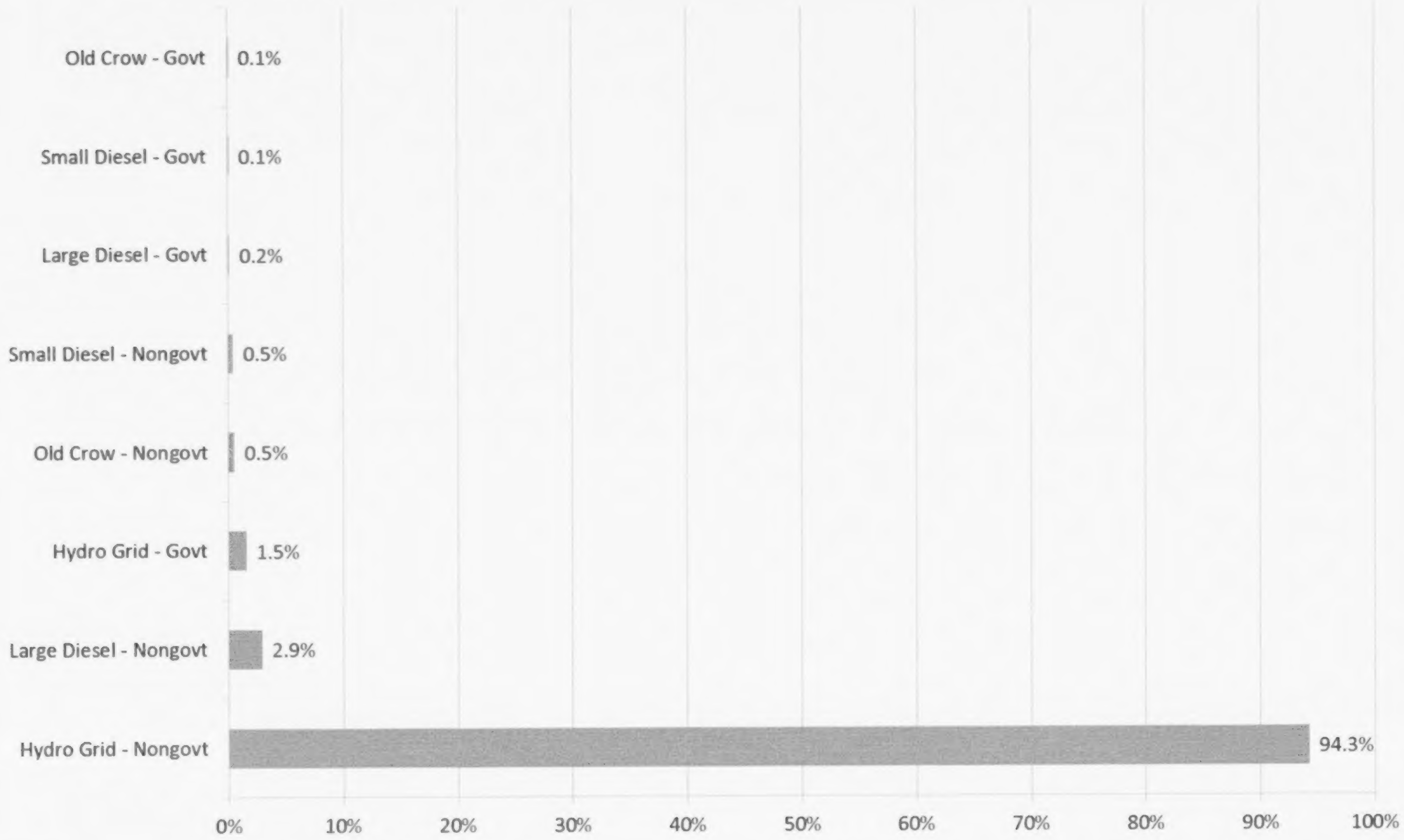
1) Results are measured at the customer's point-of-use and do not include line losses.
2) Any differences in totals are due to rounding.
3) Rounding reduces many non-zero values in this table to apparent zeroes.
4) Both the dwelling types and end uses in this exhibit are summary groupings. Data Manager can be used to display the more disaggregated results.

Exhibit 19 Distribution of Electricity Consumption in 2030 by Dwelling Type



Totals may not add to 100% due to rounding.

Exhibit 20 Distribution of Electricity Consumption, by Supply Type and Government versus Non-government in 2030



Totals may not add to 100% due to rounding.

Exhibit 21 Distribution of Electricity Consumption in 2030 by End Use

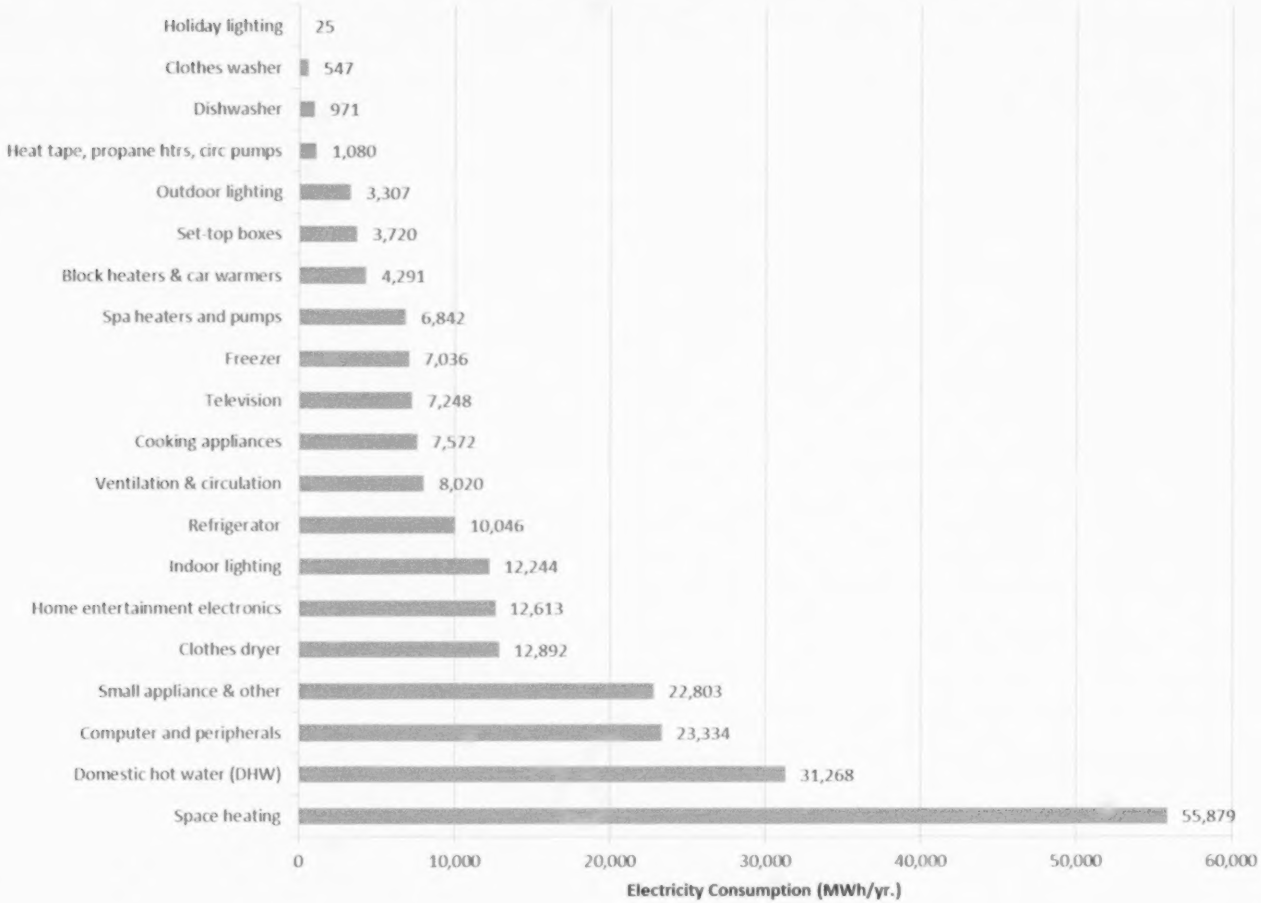
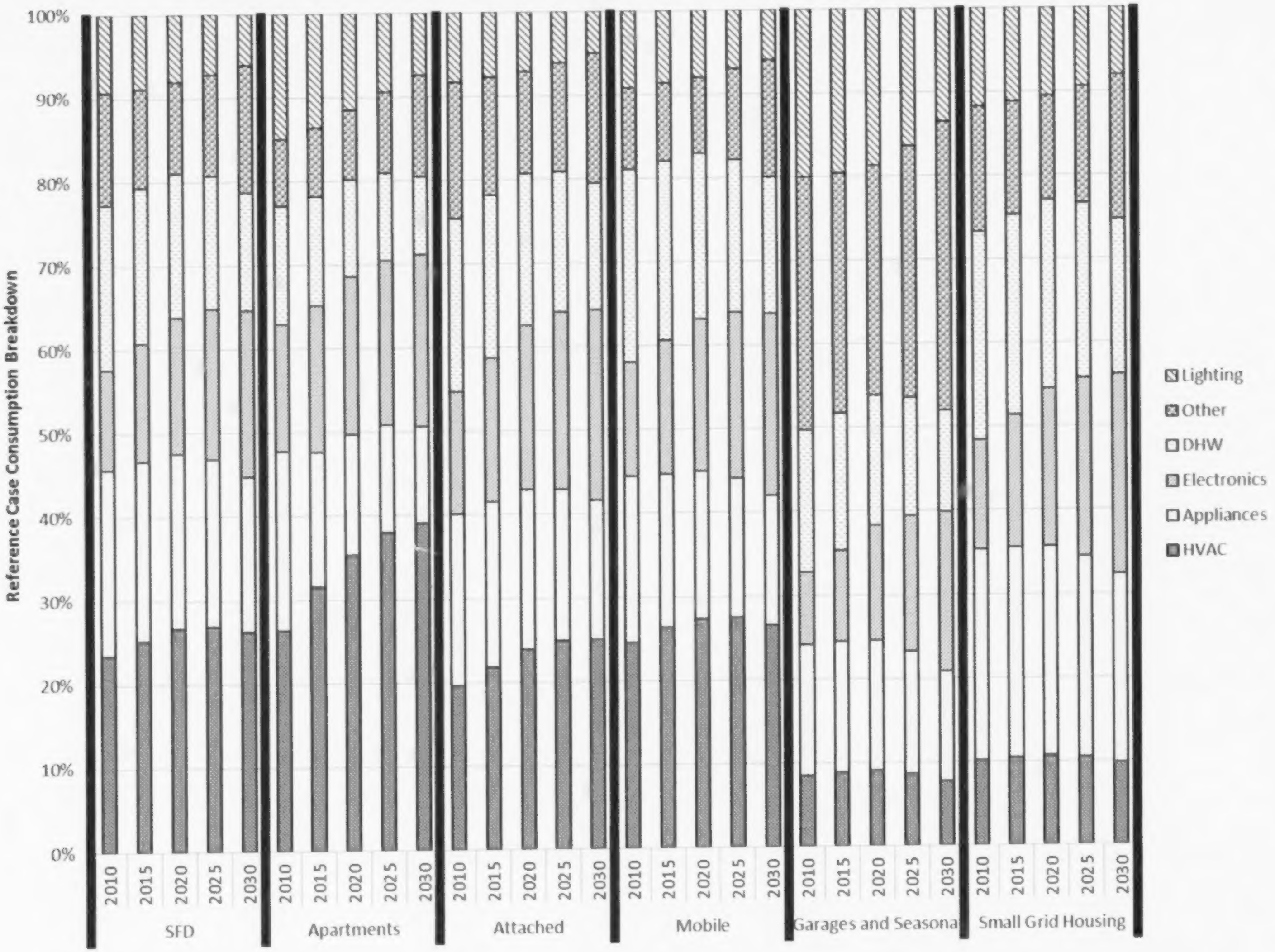


Exhibit 22 Distribution of Electricity Consumption, by Dwelling Type and End Use, Trends to 2030



6 Reference Case Electric Peak Load Forecast

6.1 Introduction

This section provides a profile of the electric peak load for Yukon's Residential sector over the Reference Case period of 2010 to 2030. The Reference Case peak load profile estimates the expected level of demand in each of the three peak periods that would occur over the study period in the absence of new DSM initiatives or rate changes. The Reference Case, therefore, provides the point of comparison for the calculation of peak load savings associated with each of the subsequent scenarios that are assessed within this study.

The discussion is organized into the following sub sections:

- Methodology
- Summary of results.

6.2 Methodology

The electric peak loads for each combination of end use, dwelling type and milestone year were calculated in exactly the same manner as shown in Section 4, which presented the Base Year peak load profiles.

For this Reference Case, the electric energy consumption (from Section 5) is converted to a demand value for each of the three peak period definitions by dividing the applicable electric energy value for each dwelling type and end use by the corresponding Residential sector load shape hours-use factors, as presented in Appendix B.

6.3 Summary of Results

A summary of the Reference Case peak load profiles is presented in Exhibit 23.

Exhibit 23 Electric Peak Loads, by Milestone Year, Peak Period and Dwelling Type (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	2010	24.8	23.2	17.4
	2015	26.5	24.9	18.4
	2020	28.5	26.8	19.6
	2025	31.2	29.5	21.6
	2030	34.8	33.0	24.2
Apartments	2010	3.4	3.3	2.0
	2015	4.1	4.0	2.5
	2020	5.4	5.3	3.3
	2025	7.4	7.2	4.4
	2030	10.1	9.9	6.1
Attached/Row Houses	2010	2.3	2.2	1.6
	2015	2.6	2.5	1.8
	2020	2.9	2.8	2.0
	2025	3.3	3.2	2.2
	2030	3.9	3.8	2.6
Mobile/Other	2010	2.3	2.2	1.7
	2015	2.6	2.4	1.8
	2020	2.8	2.6	2.0
	2025	3.1	2.8	2.2
	2030	3.4	3.2	2.4
Seasonal & Garage	2010	1.0	0.9	0.7
	2015	1.0	0.9	0.7
	2020	1.0	1.0	0.7
	2025	1.1	1.0	0.8
	2030	1.2	1.2	0.9
Small Grid Housing	2010	0.4	0.4	0.3
	2015	0.4	0.4	0.3
	2020	0.4	0.4	0.3
	2025	0.5	0.4	0.3
	2030	0.5	0.5	0.3
Sentinel Lighting	2010	0.1	0.1	0.1
	2015	0.1	0.1	0.2
	2020	0.1	0.1	0.2
	2025	0.2	0.1	0.2
	2030	0.2	0.1	0.2
Grand Total	2010	34.5	32.4	23.9
	2015	37.3	35.2	25.6
	2020	41.2	39.0	28.0
	2025	46.6	44.4	31.7
	2030	54.0	51.6	36.7

Selected highlights include:

- Since the hours-use factors applied are not assumed to change during the study period, trends in peak demand contributions for specific dwelling types are expected to follow the electricity consumption trends for those dwelling types. Single detached houses, for example, will continue to make the largest residential contribution to peak demand for all three demand periods, throughout the study period.
- Similarly, peak demand contributions for specific end uses are expected to follow the electricity consumption trends for those end uses. Lighting, because of natural gains in efficiency as compact fluorescent lamps are adopted, will make a gradually declining contribution towards the peak demand. In particular, the contribution of holiday lighting to the peak will diminish substantially as LED strings achieve market dominance by 2030.

The overall electricity consumption of both Home Entertainment Electronics and Small Appliance & Other trend upwards during the study period, so they would be expected to make a gradually larger contribution towards the peak demand over the course of the study period.

7 Technology Assessment: Energy-efficiency Measures

7.1 Introduction

This section identifies and assesses the economic attractiveness of the selected energy-efficiency technology measures for the Residential sector. The discussion is organized and presented as follows:

- Methodology
- Energy-efficiency technologies
- Summary of "unbundled" results
- Energy-efficiency supply curves.

7.2 Methodology

The following steps were employed to assess the energy-efficiency measures:

- Select candidate energy-efficiency measures
- Establish technical performance for each option
- Establish the capital, installation and operating costs for each option
- Calculate the cost of conserved energy (CCE) for each technology and O&M measure.

A brief description of each step is provided below.

Step 1 Select Candidate Measures

The candidate measures were selected in close collaboration with client personnel based on a combination of a literature review and previous study team experience. The selected measures are all considered to be technically proven and commercially available, even if only at an early stage of market entry. Technology costs, which will be addressed in this section, were not a factor in the initial selection of candidate technologies.

Step 2 Establish Technical Performance

Information on the performance improvements provided by each measure was compiled from available secondary sources, including the experience and on-going research work of study team members.

Step 3 Establish Capital, Installation and Operating Costs for Each Measure

Information on the cost of implementing each measure was also compiled from secondary sources, including the experience and on-going research work of study team members.

The incremental cost is applicable when a measure is installed in a new facility, or at the end of its useful life in an existing facility; in this case, incremental cost is defined as the cost difference for the energy-efficiency measure relative to the baseline technology. The full cost is applicable when an operating piece of equipment is replaced with a more efficient model prior to the end of its useful life.[20]

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[20] With some exceptions, many measures could conceivably be applied as either a full-cost measure (applicable immediately) or as an incremental cost measure (upon end of service life), depending on how financially attractive it

In both cases the costs and savings are annualized, based on the number of years of equipment life and the discount rate, and the costs incorporate applicable changes in annual O&M costs. All costs are expressed in constant 2010 dollars.

Step 4 Calculate CCE for Each Measure

One of the important sets of information provided in this section is the CCE associated with each energy-efficiency measure. The CCE for an energy-efficiency measure is defined as the annualized incremental cost of the upgrade measure divided by the annual energy savings achieved, excluding any administrative or program costs required to achieve full use of the technology or measure. All cost information presented in this section and in the accompanying measure TRC model are expressed in constant 2010 dollars.

The CCE provides a basis for the subsequent selection of measures to be included in the Economic Potential Forecast (see Section 8). The CCE is calculated according to the following formula:

$$\frac{C_A + M}{S}$$

Where:

C_A is the annualized installed cost
M is the incremental annual cost of operation and maintenance (O&M)
S is the annual kWh electricity savings

And A is the annualization factor

$$A = \frac{i(1+i)^n}{(1+i)^n - 1}$$

Where:

i is the discount rate
n is the life of the measure

The detailed CCE tables (see measure TRC model) show both "incremental" and "full" installed costs for the energy-efficiency measures, as applicable. If the measure or technology is installed in a new facility or at the point of natural replacement in an existing facility, then the incremental cost of the measure versus the cost of the baseline technology is used. If, prior to the end of its life, an operating piece of equipment is replaced with a more efficient model, then the full cost of the efficient measure is used.

The annual saving associated with the efficiency measure is the difference in annual electricity consumption with and without the measure.

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is. Therefore, for all but a few measures, the TRC model is configured to evaluate the measure at full cost and include it on that basis if it passes the screen, then roll to evaluating it on an incremental basis, and only fail it completely if it fails both tests. Where a measure is always full cost (such as the block heater timer, where the baseline technology is the "do nothing" option), the incremental cost option is excluded. Where a measure is always incremental cost (such as high-performance homes, where the baseline technology has to be a standard construction home, not no home at all), the full cost option is excluded.

It is recognized that some measures can be implemented prior to the end of their useful life, that is, early retirement. This intermediate option between full and incremental cost could increase the rate of adoption for some of the incremental measures, raising the Economic Potential savings modestly. However, in this study early retirement is treated as a program option.

The CCE calculation is sensitive to the chosen discount rate. In the CCE calculations that accompany this document, a discount rate of 5.25% (real) is used.

Step 5 Estimate Approximate "Unbundled" Electric Energy Savings Potential for Each Measure

The next step in the assessment was to prepare an approximate estimate of the potential "unbundled" electric energy savings that could theoretically be provided by each measure over the study period. The term "unbundled" means that the savings for each measure are calculated in isolation of other important factors that ultimately determine the potential for real life savings. The strength of this approach is that it provides insight into the relative size of the potential electric energy savings associated with individual measures; this perspective is often of particular value to utility DSM program design personnel who may need to consider combinations of energy-efficiency measures that differ from those selected for the CPR analysis.

However, it should be noted that the savings from individual measures cannot be used directly to calculate total savings potential. This is due primarily to two factors:

- More than one upgrade may affect a given end use. For example, improved insulation reduces space heating electricity use, as does the installation of new energy-efficient windows. On its own, each measure will reduce overall space heating electricity use. However, the two savings are not additive. The order in which some upgrades are introduced is also important. In this study, the approach has been to select and model the impact of "bundles of measures" that reduce the load for a given end use (e.g., wall insulation and window upgrades that reduce the space heating load) and then to introduce measures that meet the remaining load more efficiently (e.g., a high-efficiency space heating system).

- There are interactive effects among end uses. For example, the electricity savings from more efficient appliances and lighting result in reduced waste heat. During the space heating season, appliance and lighting waste heat contributes to the building's internal heat gains, which lower the amount of heat that must be provided by the space heating system. The magnitude of the interactive effects can be significant. Based on selected building energy use simulations, a 100 kWh savings in appliance or lighting electricity use results, on average, in an increased space heating load of 59 kWh to 66 kWh, depending on housing detachment type, vintage and geographical location.

The above factors are incorporated in later stages of the analysis.

Step 6 Prepare Energy-efficiency Supply Curves

The final step in the assessment of the selected energy-efficiency measures was the generation of a set of energy-efficiency supply curves. Supply curves are built up based on the conserved electricity and the CCE for each measure. The RSEEM model was used to model the application of all technically feasible measures, accumulating the electricity savings and associated implementation costs for each dwelling type.

Measures were applied sequentially to account, at least approximately, for interaction between measures. The impact of building shell measures was modelled using HOT2000, but only individually. The full package of measures was not modelled together, nor was the impact of internal gains on space heating and cooling included. These effects will be modelled more thoroughly for the Economic Potential calculation, when all the measures that pass the economic screen will be modelled together.

The accumulated savings and costs for each measure were added together to present the overall supply curve for the province. They were sorted in order from lowest cost per kWh saved to highest cost, and presented on a graph showing CCE versus electricity savings.

7.3 Energy-efficiency Technology Assessment

Exhibit 24 shows the energy-efficiency technologies and measures that are included in this study. A description and detailed financial and economic assessment of each measure is provided in the measure TRC model that accompanies this report.

Exhibit 24 Energy-efficiency Technologies Included in this Study

Heating: Equipment
- Cold temperature heat pumps
- Ductless mini-split systems
- Ground-source heat pumps (closed loop)
- Programmable thermostats (central heating)
- Programmable thermostats (baseboard heating)
- Outdoor temperature reset
- Zone heating
- Solar pre-heat makeup air
- High-efficiency heat recovery ventilators (HRVs)
- Efficient furnace motors

Heating: Shell Measures
- Attic insulation
- Wall insulation
- Slab insulation
- Basement (foundation) insulation
- Crawl space insulation
- Air sealing/weather stripping/caulking
- Air leakage sealing and insulation (old homes)
- High-performance (triple-paned) windows
- Super high-performance (quad-paned) windows
- Optimizing glazing for passive solar heat

Heating: Shell (New Homes)
- High-performance new homes (EGH 85)
- Near-zero/Net-zero energy homes
- LEED certified apartment buildings

Appliances
- Induction cooktops
- Convection ovens
- High-efficiency (ENERGY STAR®) refrigerators
- High-efficiency (ENERGY STAR®) freezers
- High-efficiency (ENERGY STAR®) clothes washers
- High-efficiency (ENERGY STAR®) dishwashers

Lighting
- Compact fluorescent lamps (CFL) – indoor
- Compact fluorescent lamps (CFL) – outdoor
- PAR compact fluorescent lamps
- Dimmable compact fluorescent lamps
- Spot or task lighting
- LED lamps
- LED holiday lighting (indoor)
- LED holiday lighting (outdoor)
- Efficient fluorescent lamps (replace T12s with T8s)
- Motion detectors for outdoor lighting
- Motion detectors for indoor lighting
- Timers for outdoor lighting

Water Heating
- DHW tank insulation
- DHW pipe insulation
- Ultra low-flow showerheads
- Wastewater heat recovery systems
- DHW recirculation systems (e.g. Metlund D'MAND™)
- DHW piping optimization

Other
- Hot tub pump timers
- High-efficiency spa pumps
- Insulating hot tub covers
- Heat pump spa heaters
- Solar spa pre-heat
- Timer/thermostat for vehicle block heaters/interior car warmers/battery blankets
- Energy-efficient (ENERGY STAR®) printers and faxes
- Energy-efficient (ENERGY STAR®) televisions
- Smart power bars (computers and peripherals)
- Smart power bars (televisions and home entertainment)
- ENERGY STAR® ceiling fans

7.3.1 Technology Screening Results

A summary of the results is provided in Exhibit 25. For each of the measures reviewed, the exhibit shows:

- The name of the measure
- The cost basis[21] for the CCE that is shown, e.g., full versus incremental
- The measure's average CCE when applied to existing dwellings and to new dwellings.

Measures analyzed on the basis of full cost have been placed towards the top of Exhibit 25 because they are qualitatively different from the measures that pass only on an incremental basis. A measure that passes on a full-cost basis can be applied immediately, even if the piece of equipment it replaces or improves is currently working properly. That means the rate at which the measure can be implemented as a utility DSM measure is limited by market and program constraints. A measure that passes only on an incremental basis, on the other hand, is limited by the rate of natural replacement (due to failure or obsolescence) or purchase of the piece of equipment it replaces. A measure that passes on a full-cost basis in some dwelling types and on an incremental cost basis in others is shown as "Full/Incr."

Exhibit 25 Residential Sector Energy-efficiency Technology Measures, Screening Results[22]

Measure Name	Basis (Full/ Incremental)	Average CCE (¢/kWh)	
		Existing Homes	New Homes
DHW Pipe Insulation	Full	0.23	0.29
Ultra Low-Flow Showerheads	Full	0.77	1.10
Hot Tub Pump Timers	Full	0.90	1.23
Programmable Thermostats (Central Heating)	Full	1.04	1.23
Compact Fluorescent Lamps (CFL) - Indoor	Full	1.09	1.09
Compact Fluorescent Lamps (CFL) - Outdoor	Full	1.64	1.64
Insulating Hot Tub Covers	Full	1.85	2.52
Timers for Electric Car Warmers	Full	2.42	2.44
Programmable Thermostats (Baseboard Heating)	Full	4.55	5.20
Motion Detectors for Outdoor Lighting	Full	4.80	4.80
Solar Spa Pre-heat	Full	4.84	6.58
Motion Detectors for Indoor Lighting	Full	5.06	5.06
Heat Pump Spa Heaters	Full	5.31	7.18
Timer/Thermostat for Block Heaters	Full	5.54	5.48
LED Holiday Lighting (Outdoor)	Full	7.75	6.54
Dimmable Compact Fluorescent Lamps	Full	6.62	6.62
DHW Tank Insulation	Full	6.89	9.04
Outdoor Temperature Reset	Full	8.08	9.53
Spot/Task Lighting	Full	8.28	8.28
Smart Power Bars (Computers and Peripherals)	Full	8.32	8.47
Dimmable PAR Compact Fluorescent Lamps	Full	8.83	8.83
Attic Insulation	Full	8.94	
SuperGreen Homes (EGH rating of 85)	Full		9.51
Basement (Foundation) Insulation	Full	10.30	

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[21] See Step 4 in Section 7.2 for a fuller description.

[22] Average CCE does not include program costs.

Measure Name	Basis (Full/ Incremental)	Average CCE (¢/kWh)	
		Existing Homes	New Homes
LEED Certified Apartment Buildings	Full		10.43
LED Lamps	Full	11.37	11.37
Air Leakage Sealing and Insulation (Old Homes)	Full	11.97	
Smart Power Bars (Televisions and Home Entertainment)	Full	14.64	12.25
DHW Recirculation Systems (e.g. Metlund D'MAND)	Full	12.51	16.91
Ductless Mini-Split Systems	Full	13.37	13.75
Zone Heating	Full	13.56	15.98
Air Sealing/Weather Stripping/Caulking	Full	13.90	
Wastewater Heat Recovery Systems	Full	14.07	18.13
Cold Climate Air Source Heat Pumps	Full	16.99	20.77
DHW Piping Optimization	Full	22.94	20.23
High-efficiency Spa Pumps	Full	21.53	29.27
Wall Insulation	Full	21.92	
Crawlspace Insulation	Full	24.56	
Timers for Electric Battery Blankets	Full	26.75	26.46
Slab Insulation (Unfinished Basements)	Full	27.08	
Solar Pre-heated Make-Up Air Systems (e.g., SolarWall®)	Full	27.94	31.40
LED Holiday Lighting (Indoor)	Full	29.06	29.06
Near-zero/Net-zero Energy Homes	Full		36.40
Timers for Outdoor Lighting	Full	64.72	64.72
High-Efficiency Furnace Blower Motors (ECPM)	Full/Incr.	21.13	15.37
High-Efficiency (ENERGY STAR®) Clothes Washers	Full/Incr.	17.55	17.97
Ground Source Heat Pumps (Closed Loop)	Full/Incr.	35.77	38.91
High-Efficiency (ENERGY STAR®) Refrigerators	Incr.	6.32	6.56
Future Improvements to Electronics	Incr.	11.63	10.89
Triple-glazed Windows	Incr.	23.27	10.94
High-Efficiency (ENERGY STAR®) Dishwashers	Incr.	12.38	16.44
High-Efficiency (ENERGY STAR®) Freezers	Incr.	13.37	13.88
Efficient Fluorescent Fixtures (Replace T12s with T8s)	Incr.	14.67	14.67
Energy Efficient (ENERGY STAR®) Printers and Faxes	Incr.	15.76	16.04
Quadruple-glazed Windows	Incr.	33.81	20.56
Energy Efficient (ENERGY STAR®) Televisions	Incr.	23.94	23.94
High-efficiency Heat Recovery Ventilators (HRVs)	Incr.	28.32	32.54
Optimizing of Glazing for Passive Solar Heating	Incr.	29.04	89.65
Convection Ovens - Electric	Incr.	48.18	61.41
ENERGY STAR® Ceiling Fans	Incr.	178.26	178.26
High-Efficiency Cooktops (Induction)	Incr.	492.13	627.23

7.4 Energy-efficiency Supply Curves

A supply curve was constructed based on the approximate Technical Potential savings associated with the above measures. The following approach was used:

- Measures were introduced in sequence
- Where more than one measure affected the same end use, the savings shown for the second measure are incremental to those already shown for the first

- Sequence was determined by listing first the items that reduce the electrical load, then those that meet residual load with the most efficient technology. It includes consideration of CCE results from the preceding exhibit
- Items appear in order, starting with the lowest average CCE, but do not stop at a specified CCE level. Hence, it presents a type of Technical Potential scenario.

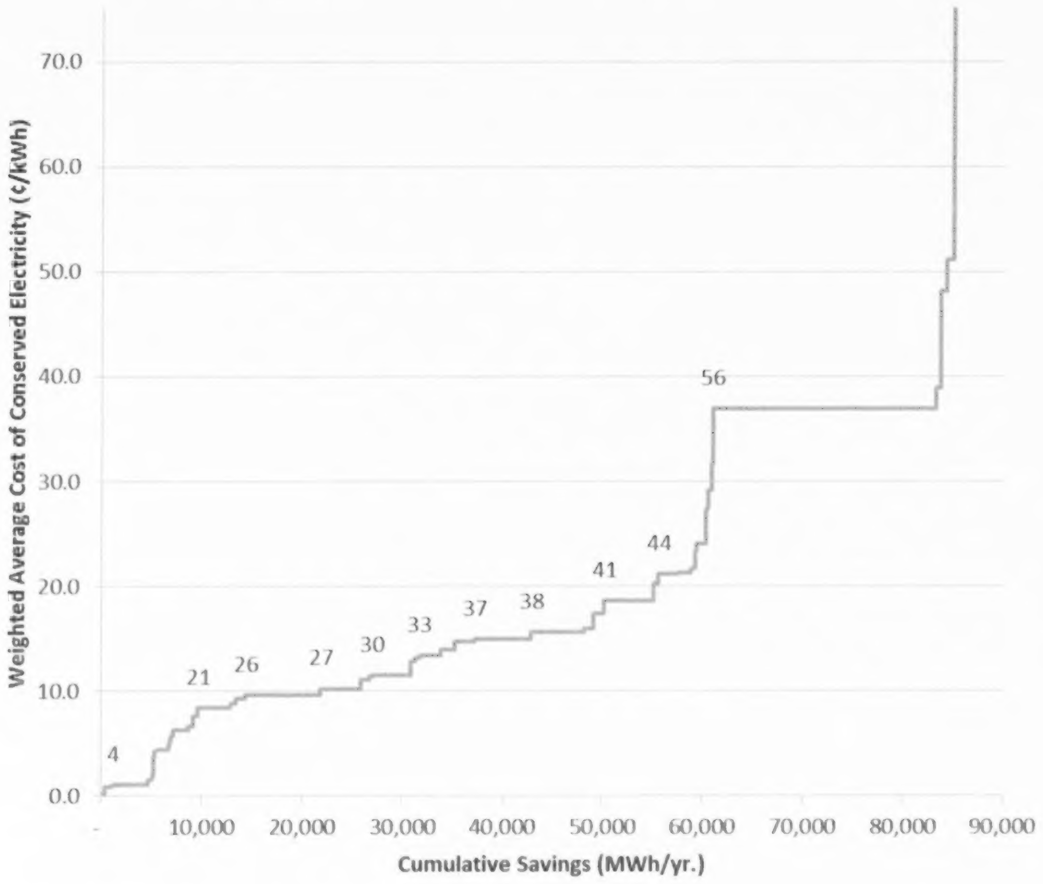
Exhibit 26 shows the measures included in the supply curve and Exhibit 27 shows the supply curve. A few of the reference numbers in the left hand column of Exhibit 26 have been placed on the supply curve as landmarks.

Exhibit 26 Summary of Residential Sector Energy-efficiency Measures, 2030

Ref #	Measure	Technical Potential Savings (MWh/yr.)	Accumulated CCE ($)	Weighted Average CCE (¢/kWh)
1	DHW Pipe Insulation	306	757	0.2
2	Showerheads	645	5,427	0.8
3	Hot Tub Pump Timers	252	2,469	1.0
4	CFLs - Indoor	3,467	37,878	1.1
5	Prog. Thermostats (Central)	323	4,884	1.5
6	CFLs - Outdoor	33	546	1.7
7	Car Warmer Timers	148	2,887	1.9
8	Hot Tub Covers	22	433	2.0
9	Pulse start metal halide sentinel lights	137	5,194	3.8
10	Prog. Thermostats	217	9,316	4.3
11	Block Heater Timers	1,190	52,949	4.4
12	Motion Detectors - Outdoor	32	1,532	4.8
13	Motion Detectors - Indoor	47	2,406	5.1
14	Solar Spa Pre-heat	81	4,290	5.3
15	Heat Pump Spa Heaters	290	16,780	5.8
16	ESTAR Refrigerators	1,452	91,010	6.3
17	Dimmable CFLs	501	33,416	6.7
18	DHW Tank Insulation	389	29,719	7.6
19	LED Holiday - Outdoor	5	415	7.8
20	Spot or Task Lighting	55	4,586	8.3
21	Power Bars (PCs)	2,548	214,572	8.4
22	Attic Insulation	718	60,676	8.4
23	Basement Insulation	83	7,184	8.6
24	PAR CFLs	430	38,284	8.9
25	Outdoor Temp Reset	924	86,194	9.3
26	High-Perf. New Homes	7,551	725,056	9.6
27	LEED Apartments	4,031	412,843	10.2
28	Sealing & Insul. - Old Homes	752	83,762	11.1
29	LED Lamps	343	39,281	11.5
30	Future Elec Improvement	3,819	438,572	11.5
31	ESTAR Dishwashers	462	59,710	12.9
32	ESTAR Freezers	467	61,841	13.2
33	Ductless Mini-Splits	2,127	285,854	13.4
34	Power Bars (TVs)	1,424	199,155	14.0
35	DHW Recirculation	1,700	251,370	14.8
36	T8 Fixtures	261	38,708	14.8

Ref #	Measure	Technical Potential Savings (MWh/yr.)	Accumulated CCE ($)	Weighted Average CCE (¢/kWh)
37	ESTAR Clothes Washers	5,593	835,820	14.9
38	Zone Heating	5,358	837,799	15.6
39	ESTAR Printers and Fax	849	135,453	15.9
40	Wastewater Heat Recovery	1,074	187,483	17.5
41	Cold Temp Heat Pumps	4,979	929,743	18.7
42	Furnace Motors	458	92,743	20.3
43	Crawl Space Insulation	7	1,467	21.0
44	Wall Insulation	1,925	407,357	21.2
45	DHW Piping Optimization	1,327	282,148	21.3
46	Battery Blanket Timers	114	24,611	21.6
47	Triple-glazed Windows	303	66,064	21.8
48	Spa Pumps	121	28,292	23.4
49	ESTAR TVs	905	217,876	24.1
50	Slab Insulation	79	19,436	24.6
51	HRVs	87	23,728	27.3
52	Optimizing Glazing for Passive	131	36,042	27.5
53	Solar Pre-heat Makeup Air	287	83,914	29.2
54	LED Holiday - Indoor	4	1,077	29.3
55	Quadruple-glazed Windows	85	27,040	31.7
56	Net Zero Homes	22,300	8,230,487	36.9
57	Ground Heat Pumps - Closed	536	208,849	39.0
58	Air Sealing	516	248,310	48.1
59	Convection Ovens	665	340,660	51.2
60	Timers - Outdoor	1	505	65.3
61	ESTAR Ceiling Fans	1,391	2,496,983	179.6
62	Induction Cooktops	342	1,787,433	523.0
	Grand Total	86,670	20,861,280	24.1

Exhibit 27 Technical Energy-efficiency Supply Curve for Residential Sector, 2030



8 Economic Potential: Electric Energy Forecast

8.1 Introduction

This section presents the Residential sector Economic Potential Forecast for electric energy for the study period 2010 to 2030. The Economic Potential Forecast estimates the level of electricity consumption that would occur if all equipment and building envelopes were upgraded to the level that is cost effective against the economic threshold values for electricity in the four supply system areas in Yukon. In this study, "cost effective" means that the technology upgrade cost, referred to as the cost of conserved energy (CCE) in the preceding section, is equal to or less than the economic threshold value for a given supply system.

The discussion in this section covers the following:

- Avoided cost used for screening
- Major modelling tasks
- Technologies included in Economic Potential Forecast
- Presentation of results
- Interpretation of results
- Energy-efficiency supply curves
- Summary of peak load reductions.

8.2 Avoided Cost Used For Screening

YECL, YEC, and the Government of Yukon agreed on a set economic threshold values for electricity supply to be used in this study. The values vary by supply system, as follows:

- Residential accounts on the Hydro Grid: $0.35/kWh
- Residential accounts on Large Diesel and Small Diesel systems: $0.30/kWh
- Residential accounts on the Old Crow system: $0.64/kWh.

The Economic Potential Forecast then incorporates all the electric energy-efficient upgrades that the technology assessment found to have a CCE equal to or less than these thresholds.

The purpose for establishing these thresholds as the economic cut-off values for new avoided electrical supply is to provide the CPR with a reasonably useful time horizon (life) to allow planners to examine options that may become more cost effective over time.

Emerging end-use technology measures are becoming cheaper over time as these markets become more cost effective. This is apparent by examining a range of measures that have become very low cost (e.g., CFLs reduced by a factor of 5-10x since introduction; the same applies to more efficient motors, light sources and appliances). Including these apparently more costly measures in this study allows the review of these measures in the near future, as programs are effective in introducing more competitiveness within these markets.

In addition, electrical supply costs are rising as more expensive generating sources are used to lower the carbon content of electricity either through the use of new fossil fuel technologies, such as carbon capture and storage (CCS), or the use of renewable (e.g., wind) or alternative energy sources (e.g., combined heat and power [CHP]).

8.3 Major Modelling Tasks

By comparing the results of the Residential sector Economic Potential Electric Energy Forecast with the Reference Case, it is possible to determine the aggregate level of potential electricity savings within the Residential sector, as well as identify which specific building sub sectors and end uses provide the most significant opportunities for savings.

To develop the Residential sector Economic Potential Forecast, the following tasks were completed:

- The CCE for each of the energy-efficient upgrades presented in Exhibit 25 were reviewed, using the 5.25% (real) discount rate.
- Technology upgrades that had a CCE equal to, or less than, the threshold values for each supply system were selected for inclusion in the Economic Potential scenario, either on a full-cost or incremental basis. It is assumed that technical upgrades having a full-cost CCE that met the cost threshold were implemented in the first forecast year. It is assumed that those upgrades that only met the cost threshold on an incremental basis are being introduced more slowly as the existing stock reaches the end of its useful life.
- Electricity use within each of the building sub sectors was modelled with the same energy models that were used to generate the Reference Case. However, for this forecast, the remaining baseline technologies included in the Reference Case forecast were replaced with the most efficient technology upgrade option and associated performance efficiency that met the cost thresholds for each supply system.
- When more than one upgrade option was applied to a given end use, the first measure selected was the one that reduced the electrical load. For example, measures to reduce the overall space heating load (e.g., attic insulation and more efficient windows) were applied before the ground-source heat pump.

8.4 Technologies Included in Economic Potential Forecast

Exhibit 28 provides a listing of the technologies selected for inclusion in this forecast. In each case, the exhibit shows the following:

- End use affected
- Upgrade option(s) selected
- Dwelling types to which the upgrade options were applied
- Rate at which the upgrade options were introduced into the stock.

Exhibit 28 Technologies Included in Economic Potential Forecast

End Use	Upgrade Option	Applicability	Rate of Introduction
Heating and Ventilation Equipment	Cold Temp Heat Pumps	Electrically Heated Detached, Attached, Mobile	Viable to install immediately
	Ductless Mini-Splits	Electrically Heated Detached, Attached, Mobile	Viable to install immediately
	Furnace Motors	Detached, Attached, Mobile	Immediate in some dwelling types; at rate of replacement in others
	Ground Heat Pumps - Closed	All Electrically Heated Residential	Immediate in some dwelling types; at rate of replacement in others
	HRVs	Electrically Heated Detached, Attached, Mobile	At natural rate of equipment replacement
	Outdoor Temp Reset	All Electrically Heated Residential	Viable to install immediately
	Prog. Thermostats	All Electrically Baseboard Residential	Viable to install immediately
	Prog. Thermostats (Central)	All Electrically Forced Air Residential	Viable to install immediately
	Solar Pre-heat Makeup Air	Electrically Heated Detached, Attached, Mobile	Viable to install immediately
	Zone Heating	All Electrically Heated Residential	Viable to install immediately
Existing Building Shell Measures	Air Sealing	Electrically Heated Detached, Attached, Mobile	Viable to install immediately
	Attic Insulation	Electrically Heated Detached, Attached, Mobile	Viable to install immediately
	Basement Insulation	Electrically Heated Detached, Attached	At rate of renovation
	Optimizing Glazing for Passive	All Electrically Heated Residential	At rate of renovation
	Quadruple-glazed Windows	All Electrically Heated Residential	At rate of renovation
	Sealing & Insul. - Old Homes	Electrically Heated Older Detached, Attached, Mobile	At rate of renovation
	Slab Insulation	Electrically Heated Detached, Attached	At rate of renovation
	Triple-glazed Windows	All Electrically Heated Residential	At rate of renovation
	Wall Insulation	Electrically Heated Detached, Attached, Mobile	At rate of renovation
New Whole Building Measures	High-Perf. New Homes	New Electrically Heated Detached, Attached	Viable for new construction
	LEED Apartments	New Apartment Buildings	Viable for new construction
Crawl Space Insulation	ESTAR Dishwashers	All Residential	At natural rate of equipment replacement
	DHW Recirculation	All Residential	Viable to install immediately
	ESTAR Clothes Washers	All Residential	Immediate in some dwelling types; at rate of replacement in others
	High-Perf. New Homes	New Electrically Heated Detached, Attached	Viable to install immediately
	DHW	Electrically Heated Detached, Attached, Mobile	Viable to install immediately
	DHW Tank Insulation	All Residential	Viable to install immediately
	DHW Piping Optimization	All Residential	Viable to install immediately
	Showerheads	All Residential	Viable to install immediately

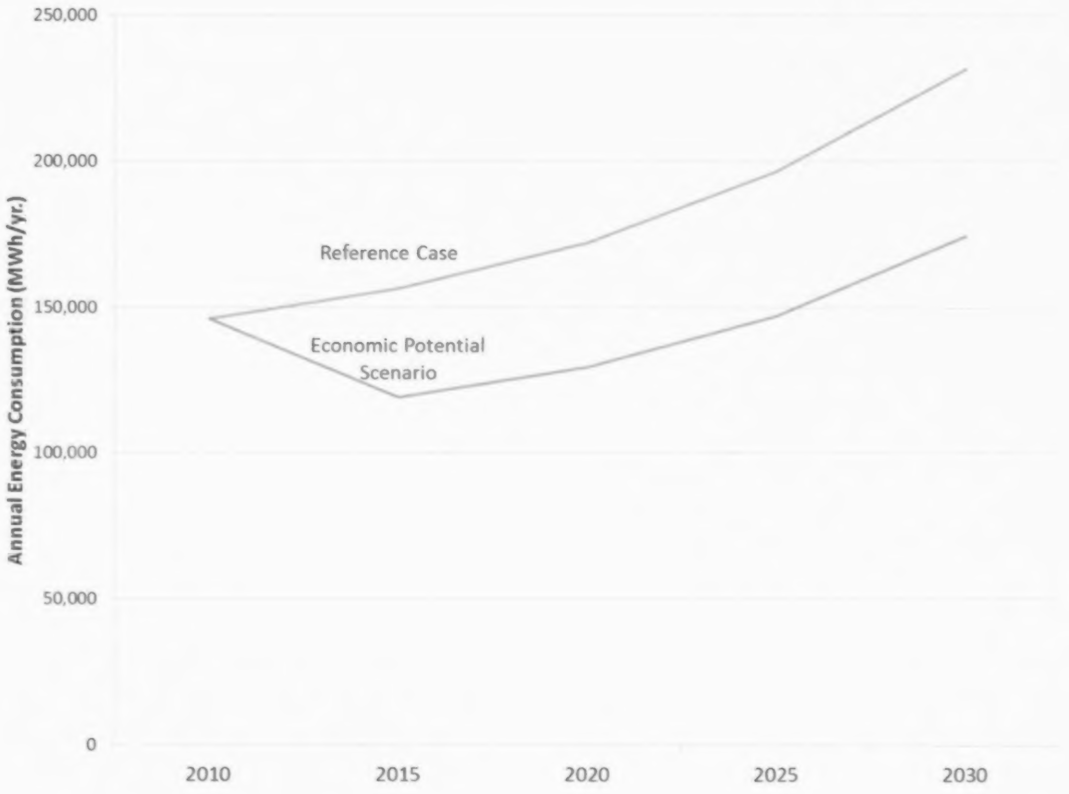
End Use	Upgrade Option	Applicability	Rate of Introduction
ESTAR Printers and Fax	Lighting	New Apartment Buildings	Viable to install immediately
	LED Lamps	All Residential	Viable to install immediately
	CFLs - Indoor	All Residential	Viable to install immediately
	Motion Detectors - Outdoor	All Residential	Viable to install immediately
	Motion Detectors - Indoor	All Residential	Viable to install immediately
	PAR CFLs	All Residential	Viable to install immediately
	Spot or Task Lighting	All Residential	Viable to install immediately
	LED Holiday - Outdoor	All Residential	Viable to install immediately
	Dimmable CFLs	All Residential	Viable to install immediately
	T8 Fixtures	All Residential	At natural rate of equipment replacement
	Pulse start metal halide sentinel lights	Sentinel Lighting	Viable to install immediately
	CFLs - Outdoor	All Residential	Viable to install immediately
LED Holiday - Indoor	Appliances	Electrically Heated Detached, Attached, Mobile	Viable to install immediately
	ESTAR Freezers	All Residential	At natural rate of equipment replacement
	ESTAR Refrigerators	All Residential	At natural rate of equipment replacement
	ESTAR Clothes Washers	All Residential	Immediate in some dwelling types; at rate of replacement in others
LEED Apartments	ESTAR TVs	All Residential	At natural rate of equipment replacement
	Power Bars (TVs)	All Residential	Viable to install immediately
	Power Bars (PCs)	All Residential	Viable to install immediately
	Electronics	All Residential	Immediate in some dwelling types; at rate of replacement in others
	Future Elec Improvement	All Residential	At natural rate of equipment replacement
ESTAR Dishwashers	Car Warmer Timers	All Residential	Viable to install immediately
	Other	All Electrically Heated Residential	At natural rate of equipment replacement
	Spa Pumps	All Residential	Viable to install immediately
	Block Heater Timers	All Residential	Viable to install immediately
	Solar Spa Pre-heat	All Residential	Viable to install immediately
	Heat Pump Spa Heaters	All Residential	Viable to install immediately
	Battery Blanket Timers	All Residential	Viable to install immediately
	Hot Tub Pump Timers	All Residential	Viable to install immediately

8.5 Summary of Electric Energy Savings

Exhibit 29 compares the Reference Case and Economic Potential Electric Energy Forecast levels of residential electricity consumption.[23] As illustrated, under the Reference Case residential electricity use would grow from the Base Year level of 146,000 MWh/yr. to approximately 232,000 MWh/yr. by 2030. This contrasts with the Economic Potential Forecast in which electricity use would increase to approximately 174,000 MWh/yr. for the same period, a difference of approximately 57,000 MWh/yr., or about 25%.

Most measures pass the economic screen for at least some dwelling types and supply systems.
25% is a larger economic potential than is usually seen for the residential sector. This is due mainly to more severe climate and higher costs for new generation options.

Exhibit 29 Reference Case versus Economic Potential Electric Energy Consumption in Residential Sector (MWh/yr.)



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[23] All results are reported at the customer's point-of-use and do not include line losses.

8.5.1 Electric Energy Savings

Further detail on the total potential electric energy savings provided by the Economic Potential Forecast is provided in the following exhibits:[24]

- Exhibit 30 presents the results by end use, dwelling type and milestone year
- Exhibit 31 provides a further disaggregation of the savings by end use, technology, milestone year and cost
- Exhibit 32 presents savings by major end use, milestone year and supply system
- Exhibit 33 presents savings by major end use, milestone year and dwelling type
- Exhibit 34 presents 2030 savings by major end use and vintage.

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[24] MWh/yr. savings shown in the following exhibits are not incremental. For example, the space heating savings in 2030 are not in addition to the space heating savings from the previous milestone years. Rather, they are the difference between the Reference Case space heating consumption in 2030 and the space heating consumption if all the measures included in the Economic Potential scenario are implemented.

Exhibit 30 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year (MWh/yr.)

Dwelling Type	Milestone Year	Space heating	Domestic hot water (DHW)	Indoor lighting	Computer and peripherals	Clothes dryer	Television	Block heaters & car warmers	Refrigerator	Ventilation & circulation
Single Detached House	2015	10,903	4,172	3,825	1,810	2,223	815	708	295	972
	2020	13,063	4,661	3,575	2,069	2,493	1,196	761	629	813
	2025	15,296	5,159	3,262	2,667	2,785	1,276	812	954	628
	2030	17,635	5,582	2,836	3,369	2,949	1,417	861	1,039	396
Apartment/Condo Suites and Common Areas	2015	609	513	1,178	342	211	154	179	39	7
	2020	1,365	748	1,237	445	259	257	217	90	19
	2025	2,455	1,086	1,291	665	336	318	268	154	35
	2030	3,934	1,527	1,315	986	418	415	333	192	58
Attached Dwelling	2015	885	478	406	231	209	104	91	31	96
	2020	1,196	569	390	273	231	158	100	67	83
	2025	1,558	675	367	365	255	175	111	106	68
	2030	1,962	793	334	479	281	202	123	119	50
Mobile	2015	958	469	392	198	130	89	77	23	157
	2020	1,113	505	369	226	138	130	83	50	140
	2025	1,266	543	340	290	147	139	88	75	120
	2030	1,416	577	300	366	155	154	94	81	96
Small Grid Housing	2015	2	-	381	-	-	-	23	-	1
	2020	3	-	346	-	-	-	24	-	1
	2025	3	-	308	-	-	-	25	-	1
	2030	4	-	261	-	-	-	26	-	0
Garages and Seasonal Housing	2015	-	80	89	37	18	17	14	6	14
	2020	-	88	80	41	37	23	15	13	15
	2025	-	94	71	51	53	24	15	19	17
	2030	-	95	60	63	55	26	16	20	13
Sentinel Lighting	2015	-	-	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-	-	-
	2030	-	-	-	-	-	-	-	-	-
Totals	2015	13,357	5,712	6,271	2,618	2,791	1,179	1,092	394	1,247
	2020	16,739	6,571	5,998	3,053	3,157	1,765	1,200	849	1,071
	2025	20,577	7,558	5,640	4,038	3,575	1,932	1,320	1,308	870
	2030	24,951	8,574	5,105	5,262	3,857	2,214	1,453	1,452	613

Notes:
1) Results are measured at the customer's point-of-use and do not include line losses.
2) Any differences in totals are due to rounding.
3) In the above exhibit a value displays as 0 if it is between 0 and 0.5. Totals are calculated using the actual numerical value.
4) MWh/yr. savings are not incremental. The space heating savings in 2030 are not in addition to the savings from the previous milestone years. Rather, they are the difference between the Reference Case space heating consumption in 2030 and the space heating consumption if all the measures included in the Economic Potential scenario are implemented.

Exhibit 30 Continued: Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year (MWh/yr.)

Dwelling Type	Milestone Year	Spa heaters and pumps	Home entertainment electronics	Outdoor lighting	Freezer	Clothes washer	Set-top boxes	Dishwasher	Holiday lighting	Grand Total
Single Detached House	2015	1,091	114	365	63	134	-	25	84	27,605
	2020	714	185	264	139	127	-	53	56	30,803
	2025	609	495	150	229	127	105	63	30	34,650
	2030	596	1,198	24	336	125	223	69	6	38,663
Apartment/Condo Suites and Common Areas	2015	46	16	58	8	12	-	2	16	3,390
	2020	34	29	55	20	13	-	5	13	4,806
	2025	34	91	47	36	15	26	7	8	6,874
	2030	39	260	34	60	18	65	9	2	9,666
Attached Dwelling	2015	140	11	36	7	12	-	2	6	2,745
	2020	95	18	26	15	12	-	5	4	3,239
	2025	84	49	14	25	12	14	6	2	3,886
	2030	86	123	2	38	12	32	6	1	4,640
Mobile	2015	61	11	38	5	8	-	1	6	2,624
	2020	40	18	27	11	7	-	3	4	2,863
	2025	34	47	16	18	7	11	3	2	3,146
	2030	33	113	2	26	7	24	4	0	3,449
Small Grid Housing	2015	-	-	35	-	-	-	-	-	441
	2020	-	-	25	-	-	-	-	-	398
	2025	-	-	14	-	-	-	-	-	350
	2030	-	-	2	-	-	-	-	-	293
Garages and Seasonal Housing	2015	22	3	1	1	1	-	1	2	306
	2020	14	4	1	3	2	-	1	1	338
	2025	12	11	1	5	2	2	1	1	379
	2030	11	25	1	7	2	4	1	0	400
Sentinel Lighting	2015	-	-	127	-	-	-	-	-	127
	2020	-	-	129	-	-	-	-	-	129
	2025	-	-	134	-	-	-	-	-	134
	2030	-	-	137	-	-	-	-	-	137
Totals	2015	1,359	155	660	85	167	-	32	114	37,239
	2020	897	253	527	187	160	-	67	78	42,577
	2025	773	693	375	313	163	159	80	43	49,419
	2030	765	1,719	202	467	164	349	89	9	57,248

Exhibit 31 Economic Potential Electricity Savings by Measure and Milestone Year (MWh/yr.)

Measure	Applicability	Cost Basis (Full vs Incremental)	Annual Savings, 2015, MWh/yr.	Annual Savings, 2020, MWh/yr.	Annual Savings, 2025, MWh/yr.	Annual Savings, 2030, MWh/yr.
ESTAR Clothes Washers	All Residential	Full/Incr.	4,229	4,678	5,241	5,593
High-Perf. New Homes	New Electrically Heated Detached, Attached	Full	1,694	3,558	5,525	7,551
CFLs - Indoor	All Residential	Full	4,561	4,272	3,911	3,467
Zone Heating	All Electrically Heated Residential	Full	2,710	3,442	4,324	5,370
Cold Temp Heat Pumps	Electrically Heated Detached, Attached, Mobile	Full	2,952	3,583	4,267	4,997
Power Bars (PCs)	All Residential	Full	2,127	2,358	2,507	2,548
LEED Apartments	New Apartment Buildings	Full	497	1,286	2,442	4,031
Wall Insulation	Electrically Heated Detached, Attached, Mobile	Full	2,183	2,097	2,011	1,925
Ductless Mini-Splits	Electrically Heated Detached, Attached, Mobile	Full	1,254	1,525	1,819	2,134
DHW Recirculation	All Residential	Full	1,092	1,264	1,472	1,699
Future Elec Improvement	All Residential	Incr.	-	-	1,418	3,819
Power Bars (TVs)	All Residential	Full	983	1,142	1,240	1,424
DHW Piping Optimization	All Residential	Full	893	1,013	1,163	1,326
Block Heater Timers	All Residential	Full	895	984	1,082	1,190
ESTAR Refrigerators	All Residential	Incr.	394	849	1,308	1,452
Furnace Motors	Detached, Attached, Mobile	Full/Incr.	1,183	982	751	456
Showerheads	All Residential	Full	974	834	732	645
Sealing & Insul. - Old Homes	Electrically Heated Older Detached, Attached, Mobile	Full	818	795	774	752
Attic Insulation	Electrically Heated Detached, Attached, Mobile	Full	849	805	762	718
Wastewater Heat Recovery	All Residential	Full	474	658	859	1,074
ESTAR TVs	All Residential	Incr.	351	876	877	905
ESTAR Printers and Fax	All Residential	Incr.	491	695	779	849
Outdoor Temp Reset	All Electrically Heated Residential	Full	468	594	746	927
Dimmable CFLs	All Residential	Full	654	609	558	501
Air Sealing	Electrically Heated Detached, Attached, Mobile	Full	553	537	522	506
PAR CFLs	All Residential	Full	585	538	486	430
Heat Pump Spa Heaters	All Residential	Full	616	386	314	290
DHW Tank Insulation	All Residential	Full	353	358	372	389
ESTAR Dishwashers	All Residential	Incr.	185	378	437	462

Measure	Applicability	Cost Basis (Full vs Incremental)	Annual Savings, 2015, MWh/yr.	Annual Savings, 2020, MWh/yr.	Annual Savings, 2025, MWh/yr.	Annual Savings, 2030, MWh/yr.
Prog. Thermostats (Central)	All Electrically Forced Air Residential	Full	395	372	348	324
LED Lamps	All Residential	Full	264	290	316	343
Hot Tub Pump Timers	All Residential	Full	395	271	243	252
DHW Pipe Insulation	All Residential	Full	277	281	293	306
CFLs - Outdoor	All Residential	Full	499	364	208	33
ESTAR Freezers	All Residential	Incr.	85	187	313	467
Basement Insulation	Electrically Heated Detached, Attached	Full	370	275	180	83
Prog. Thermostats	All Electrically Baseboard Residential	Full	217	217	217	218
T8 Fixtures	All Residential	Incr.	86	173	258	261
Solar Pre-heat Makeup Air	Electrically Heated Detached, Attached, Mobile	Full	126	165	213	272
Triple-glazed Windows	All Electrically Heated Residential	Incr.	76	152	228	303
Ground Heat Pumps - Closed	All Electrically Heated Residential	Full/Incr.	97	143	208	292
Spa Pumps	All Residential	Full	189	130	117	121
Pulse start metal halide sentinel lights	Sentinel Lighting	Full	127	129	134	137
Car Warmer Timers	All Residential	Full	112	123	135	148
Battery Blanket Timers	All Residential	Full	86	94	104	114
Solar Spa Pre-heat	All Residential	Full	125	86	78	81
Slab Insulation	Electrically Heated Detached, Attached	Full	107	97	87	77
Optimizing Glazing for Passive	All Electrically Heated Residential	Incr.	30	60	89	117
Spot or Task Lighting	All Residential	Full	78	72	64	55
HRVs	Electrically Heated Detached, Attached, Mobile	Incr.	26	52	80	74
Motion Detectors - Indoor	All Residential	Full	43	45	46	47
LED Holiday - Outdoor	All Residential	Full	66	46	25	5
Motion Detectors - Outdoor	All Residential	Full	34	34	33	32
Quadruple-glazed Windows	All Electrically Heated Residential	Incr.	12	24	35	46
LED Holiday - Indoor	All Residential	Full	47	32	18	4
Hot Tub Covers	All Residential	Full	34	23	21	22
Crawl Space Insulation	Electrically Heated Detached, Attached, Mobile	Full	14	12	9	7
HVAC Interaction from Internal Load Reduction	Electrically Heated Detached, Attached, Mobile	Incr.	(1,797)	(2,467)	(3,378)	(4,427)
Grand Total	All Residential	Incr.	37,239	42,577	49,419	57,248

Exhibit 32 Economic Potential Savings by Major End Use, Year and Supply System (MWh/yr.)

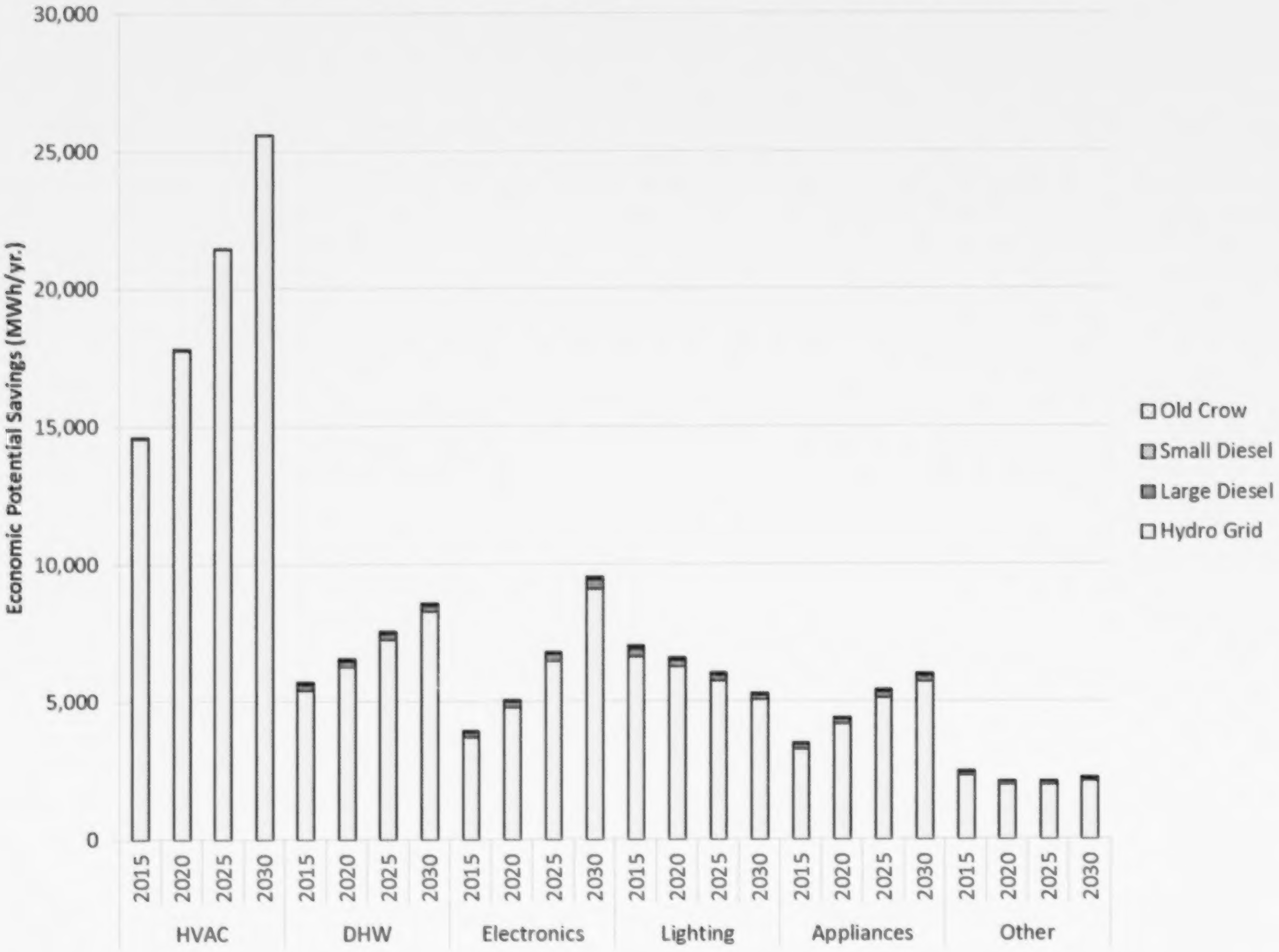


Exhibit 33 Economic Potential Savings by Major End Use, Year and Dwelling Type (MWh/yr.)

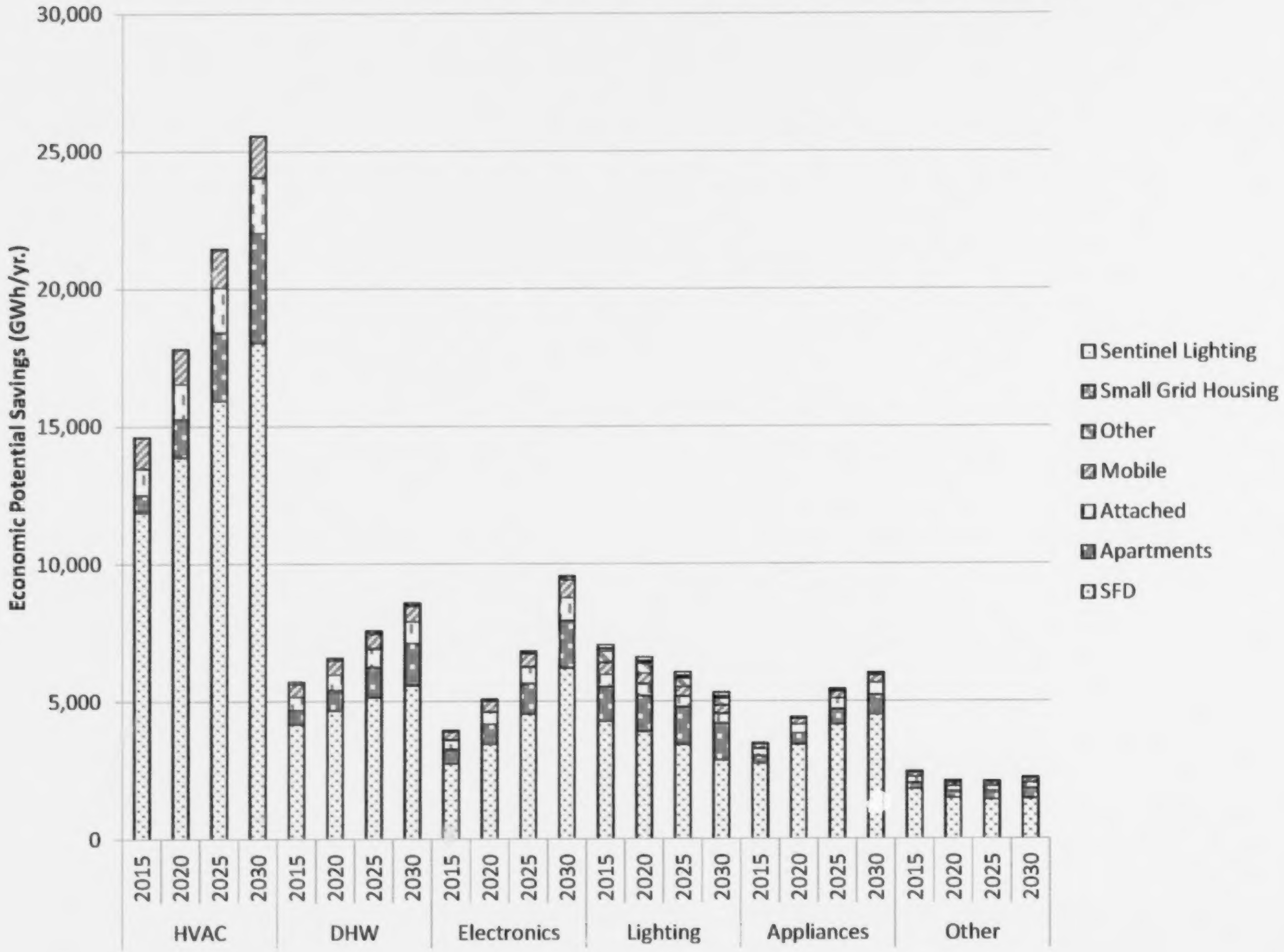
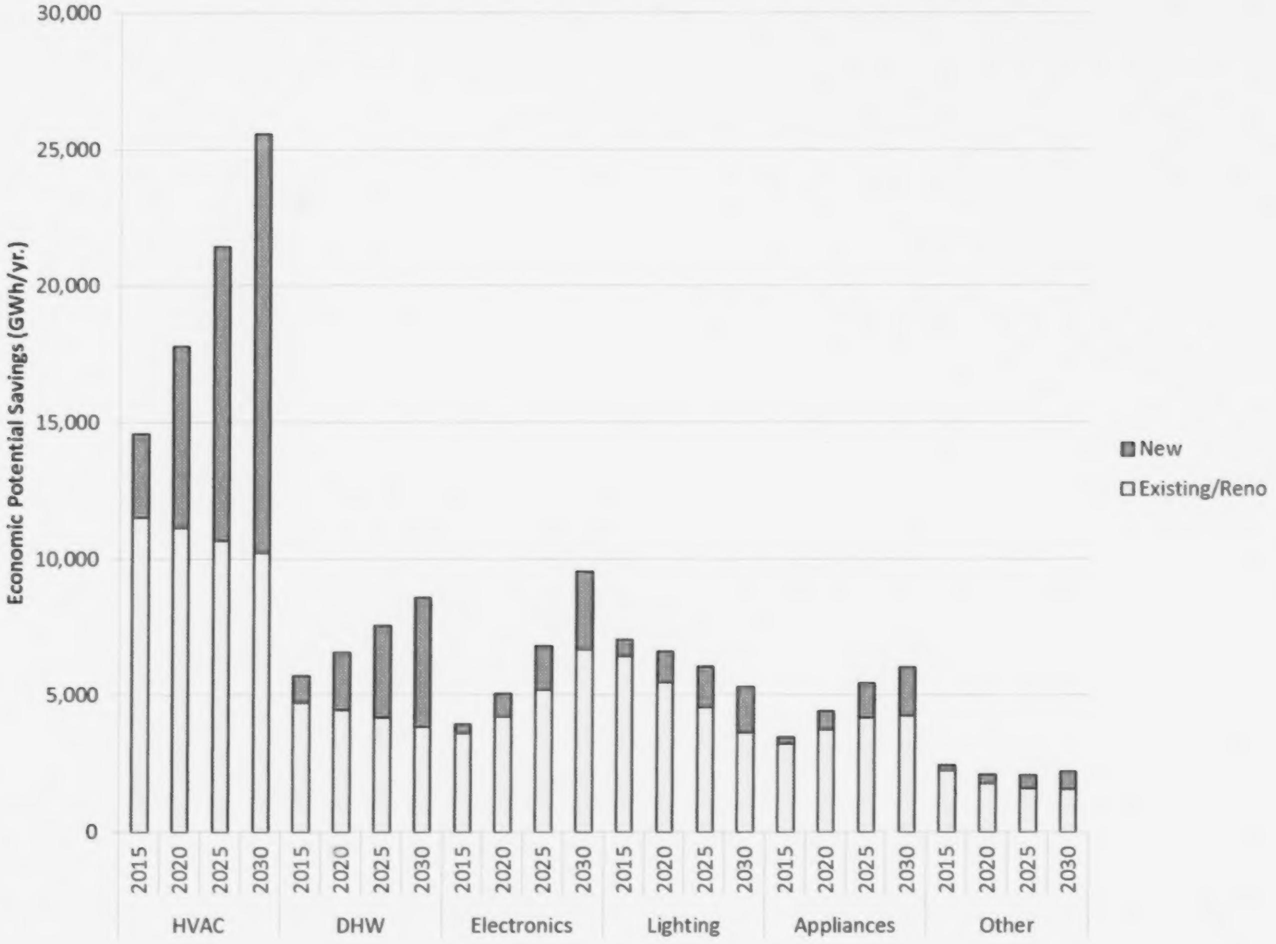


Exhibit 34 Economic Potential Savings by Major End Use, Year and Vintage (MWh/yr.)



8.5.2 Interpretation of Results

Highlights of the results presented in the preceding exhibits are summarized below:

Electric Energy Savings by Milestone Year

The Economic Potential savings increase modestly from 37,000 MWh/yr. in 2015 to 57,000 MWh/yr. in 2030. More than 65% of the savings possible at the end of the study period are already economically viable within the first milestone period. While there are end uses where the opportunities for savings expand, such as space heating and DHW, there are other end uses where the opportunities contract, such as lighting. Lighting in the Reference Case includes the assumption that 50% of the market moves to lamps as efficient as CFLs by 2030, and that almost all holiday lighting moves to LEDs. The difference between the Reference Case and the Economic Potential scenario therefore narrows with time for the lighting end uses.

Electric Energy Savings by Dwelling Type

Single detached houses and duplexes account for 68% of the potential savings; this reflects their larger market share and their generally higher level of electrical intensity per dwelling. Savings in apartments account for 17% of the potential savings in 2030. This is a much larger share than they account for in the earlier milestones, and reflects the higher level of anticipated construction of apartments relative to detached houses. Attached dwellings account for 8% of potential savings in 2030 and mobile homes account for approximately 6% of potential savings. Small grid housing accounts for 1% of potential savings in 2030, and garages and seasonal houses account for 1%. Sentinel lighting accounts for approximately 0.2% of the savings.

By Supply Type and Government versus Non-government Accounts

The accounts connected to the hydro grid are expected to account for 98% of potential savings in 2030. Large diesel accounts account for 2% and accounts on the Old Crow and small diesel grids systems account for 0.4% and 0.3%, respectively. Government accounts provide 2% of the 2030 savings and non-government accounts the remaining 98%.

By Existing Dwellings versus New Construction

Savings in existing dwellings account for 53% of potential savings in 2030, while savings in dwellings that are expected to be built during the study period account for 47% of potential savings.

Electric Energy Savings by End Use

Space heating and ventilation savings from upgrades to the building envelope and space heating systems account for approximately 45% of the total electricity savings in the Economic Potential Forecast for 2030. Of this, 13% is from high-performance new homes, 9% is from zone heating controls, 9% is from cold climate heat pumps, 7% is from LEED certified apartment buildings, 4% is ductless mini-split systems, and 3% is from wall insulation. Other measures account for 2% or less of the savings. It should be noted that the reduction in internal heat loads

Space heating measures dominate the results, including new construction, equipment options, and deep retrofits of existing homes.

resulting from measures that save electricity in other end uses will tend to increase heating energy consumption. This increase is subtracted from the overall potential savings, reducing it by approximately 8% overall by 2030.

DHW measures account for 20% of the total electricity savings in the Economic Potential Forecast for 2030. Of this, 10% is from the DHW savings associated with more efficient clothes washers and 3% is from DHW recirculation systems. Efficient piping design in new homes accounts for 2% of savings and wastewater heat recovery accounts for another 2%. Other measures account for 1% or less of the 2030 potential savings.

Electronic end uses account for about 17% of the total electricity savings in the Economic Potential Forecast in 2030. Of this, 4% is from power bars for PCs and their peripherals and 2% is from power bars for televisions and their peripherals. An additional 2% is from ENERGY STAR® televisions. The largest component of the 2030 savings is a placeholder measure called "Future Electronic Improvement." This measure was added to the study in recognition that the other electronics measures are likely to be superseded by technical changes in electronics products, but that the end use as a whole is growing very rapidly and needs to be addressed by electric utilities.

Appliances account for approximately 14% of the total electricity savings in the Economic Potential Forecast for 2030. Of this, the 10% savings from ENERGY STAR® clothes washers have already been mentioned above under DHW. An additional 3% is from ENERGY STAR® refrigerators, and about 1% each is from ENERGY STAR® freezers and ENERGY STAR® dishwashers.

The lighting end uses, including indoor, outdoor and holiday lighting, account for about 9% of the total electricity savings in 2030 in the Economic Potential Forecast. Of this, approximately 8% is from indoor and outdoor CFLs, including PAR and dimmable CFLs. Lighting potential is actually larger near the beginning of the study period because the natural adoption of CFLs is not assumed to be as large in the first milestone periods. In 2015, lighting end uses account for approximately 19% of the total electricity savings potential.

The "other" category of end uses, which includes, spas, block heaters and car warmers, and small appliances and other, account for 4% of the electricity savings in the Economic Potential Forecast for 2030. Of this, approximately 2% is from block heater timers. Other measures within this category account for 1% or less of the savings.

8.5.3 Caveats on Interpretation of Results

A systems approach was used to model the energy impacts of the efficiency upgrades presented in the preceding section. In the absence of a systems approach, there would be double counting of savings and an accurate assessment of the total contribution of the energy-efficient upgrades would not be possible. More specifically, there are two particularly important considerations:

- More than one upgrade may affect a given end use. For example, improved insulation reduces space heating electricity use, as does the installation of a heat pump. On its own, each measure will reduce overall space heating electricity use. However, the two savings are not additive. The order in which some upgrades are introduced is also important. In this study, the approach has been to select and model the impact of "bundles of measures" that reduce the load for a given end use (e.g., wall insulation and window upgrades that reduce the space heating load) and then to introduce measures that meet the remaining load more efficiently (e.g., a high-efficiency space heating system).

- There are interactive effects among end uses. For example, the electricity savings from more efficient appliances and lighting result in reduced waste heat. During the space heating season, appliance and lighting waste heat contributes to the building's internal heat gains, which lower the amount of heat that must be provided by the space heating system. The magnitude of the interactive effects can be significant. Based on selected building energy-use simulations, a 100 kWh savings in appliance or lighting electricity use results, on average, in an increased space heating load of up to 75 kWh, depending on dwelling type.

75% is a higher rate of interaction between internal loads and space heating than seen in other studies. It is related mainly to the length of the heating season, rather than its severity.

8.6 Energy-efficiency Supply Curves

A supply curve was constructed based on the approximate Economic Potential savings associated with the above measures. The following approach was followed:

- Measures are introduced in sequence to show incremental impact and cost
- Sequence was determined by listing first the items that reduce the electrical load, then those that meet residual load with the most efficient technology
- Items appear in order, beginning with those that have the lowest average CCE.

Exhibit 35 shows the measures included in the supply curve and Exhibit 36 shows the supply curve for Yukon as a whole in the 2030 milestone year. Similar exhibits are provided for the four supply systems in Appendix F. The annual savings shown for measures in this section will, in most cases, differ from the savings amounts shown in Exhibit 26.

- In most cases, values are reduced by the economic screens applied. If they fail to pass the screen for specific dwelling types the savings will be reduced and some measures are eliminated entirely.
- Values that increase in this exhibit do so because of a decrease in the energy penalty associated with space heating. Measures that save electricity within the building envelope reduce the contribution that the end use makes towards space heating. If the heating system or building envelope is made more efficient (as is the case in the Economic Potential scenario) this effect is reduced.

Exhibit 35 Summary of Residential Sector Energy-efficiency Measures, 2030[25]

Ref #	Measure	Economic Potential Savings (MWh/yr.)	Cost of Savings ($)	Weighted Average CCE (¢/kWh)
1	DHW Pipe Insulation	306	757	0.2
2	Showerheads	645	5,427	0.8
3	Prog. Thermostats (Central)	324	3,129	1.0
4	Hot Tub Pump Timers	252	2,469	1.0
5	CFLs - Indoor	3,467	37,878	1.1
6	CFLs - Outdoor	33	546	1.7
7	Car Warmer Timers	148	2,887	1.9
8	Hot Tub Covers	22	433	2.0
9	Pulse start metal halide sentinel lights	137	5,194	3.8
10	Prog. Thermostats	218	9,383	4.3
11	Block Heater Timers	1,190	52,949	4.4
12	Motion Detectors - Outdoor	32	1,532	4.8
13	Motion Detectors - Indoor	47	2,406	5.1
14	Solar Spa Pre-heat	81	4,290	5.3
15	Heat Pump Spa Heaters	290	16,780	5.8
16	ESTAR Refrigerators	1,452	91,010	6.3
17	Dimmable CFLs	501	33,416	6.7
18	DHW Tank Insulation	389	29,719	7.6
19	LED Holiday - Outdoor	5	415	7.8
20	Spot or Task Lighting	55	4,586	8.3
21	Power Bars (PCs)	2,548	214,572	8.4
22	Attic Insulation	718	60,676	8.4
23	Basement Insulation	83	7,184	8.6
24	PAR CFLs	430	38,284	8.9
25	Outdoor Temp Reset	927	86,417	9.3
26	High-Perf. New Homes	7,551	725,056	9.6
27	LEED Apartments	4,031	412,843	10.2
28	Sealing & Insul. - Old Homes	752	83,762	11.1
29	LED Lamps	343	39,281	11.5
30	Future Elec Improvement	3,819	438,572	11.5
31	Air Sealing	506	62,113	12.3
32	ESTAR Dishwashers	462	59,690	12.9
33	ESTAR Freezers	467	61,841	13.2
34	Ductless Mini-Splits	2,134	287,081	13.5
35	Power Bars (TVs)	1,424	199,155	14.0
36	DHW Recirculation	1,699	251,208	14.8

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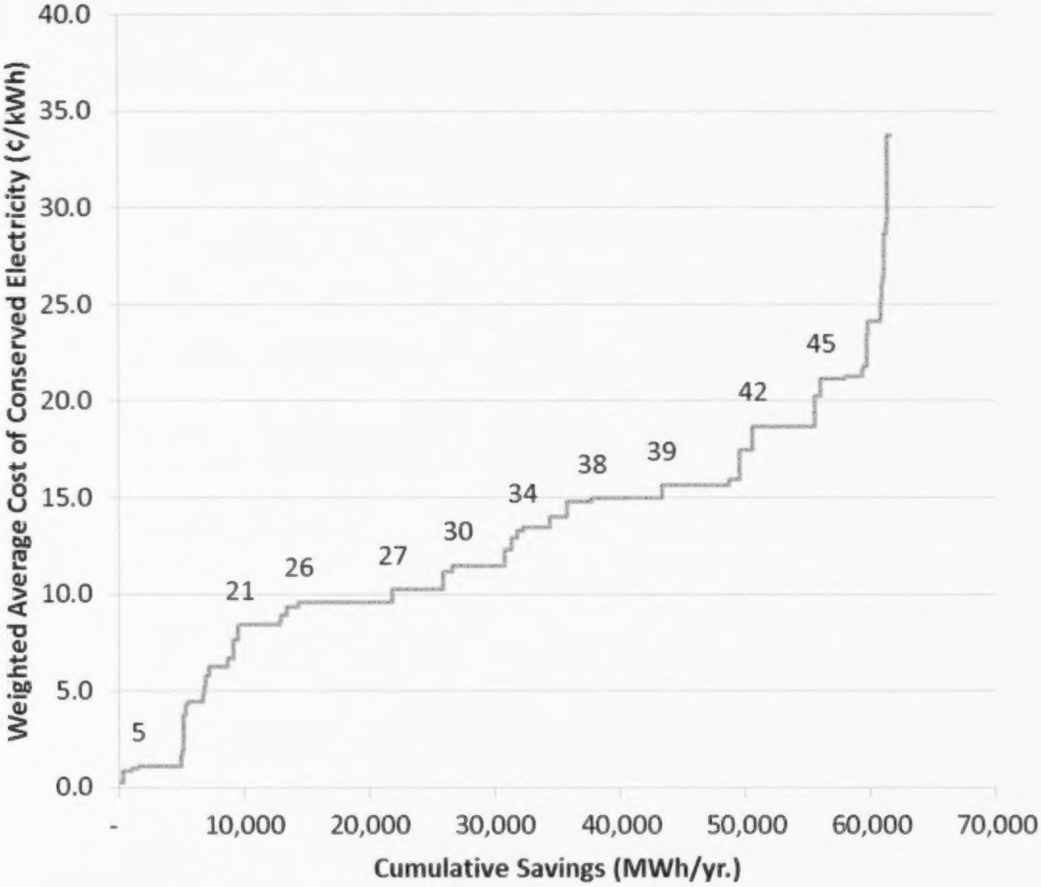
[25] The total savings in this exhibit does not match the 2030 total in Exhibit 31 because the HVAC interaction from internal load reduction is omitted from this exhibit.

Ref #	Measure	Economic Potential Savings (MWh/yr.)	Cost of Savings ($)	Weighted Average CCE (¢/kWh)
37	T8 Fixtures	261	38,708	14.8
38	ESTAR Clothes Washers	5,593	835,820	14.9
39	Zone Heating	5,370	839,962	15.6
40	ESTAR Printers and Fax	849	135,453	15.9
41	Wastewater Heat Recovery	1,074	187,484	17.5
42	Cold Temp Heat Pumps	4,997	933,749	18.7
43	Furnace Motors	456	92,320	20.2
44	Crawl Space Insulation	7	1,467	21.0
45	Wall Insulation	1,925	407,357	21.2
46	DHW Piping Optimization	1,326	281,686	21.2
47	Battery Blanket Timers	114	24,611	21.6
48	Triple-glazed Windows	303	66,064	21.8
49	Spa Pumps	121	28,241	23.4
50	ESTAR TVs	905	217,876	24.1
51	Slab Insulation	77	18,684	24.1
52	HRVs	74	18,667	25.2
53	Optimizing Glazing for Passive	117	30,546	26.0
54	Quadruple-glazed Windows	46	12,194	26.4
55	Solar Pre-heat Makeup Air	272	78,005	28.7
56	LED Holiday - Indoor	4	1,077	29.3
57	Ground Heat Pumps - Closed	292	98,681	33.8
	Grand Total	61,675	7,681,596	12.5

Exhibit 36 Energy-efficiency Supply Curve for Residential Sector, 2030



8.7 Summary of Electric Peak Load Reductions

Exhibit 37 presents a summary of the peak load reductions that would occur as a result of the electric energy savings contained in the Economic Potential Forecast. The reductions are shown by milestone year and peak period. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case presented previously in Sections 4 and 6. Exhibit 38 shows the same information graphically for the Annual Peak Hour.

Exhibit 37 and Exhibit 38 only approximate the potential demand impacts associated with the energy-efficiency measures because they are based on the assumption that the measures do not change the load shape of the end uses they affect. In fact, the block heater timer measure is expected to substantially change the load shape for that end use, because users would be encouraged to set the timers to switch on in the middle of the night, after the utility peak period is over. As an approximation, block heater timers are assumed to reduce the peak load for the block heater end use by 90% overall.

Exhibit 39 shows the demand reductions associated with each electric energy savings measure contained in the Economic Potential Forecast for the milestone year 2030. The total 2030 demand reductions in Exhibit 39 do not match those shown in the previous exhibits because it includes the assumption that block heater timers reduce block heater demand in the first two peak periods by 90%. The block heater timer measure, whose demand reduction was already disproportionately large compared to its electric energy savings, now accounts for 19% of the potential reduction in peak hour demand (Period 1) and 24% of the potential reduction in demand during the system peak period (Period 2).

Electric peak load reductions related to capacity-only measures are presented separately in Sections 9 and 10.

Exhibit 37 Electric Peak Load Reductions from Economic Energy Savings Measures, by Milestone Year, Peak Period and Dwelling Type (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	2015	7.48	7.53	4.92
	2020	8.29	8.32	5.57
	2025	9.22	9.22	6.31
	2030	10.19	10.17	7.08
Apartments	2015	0.89	0.94	0.47
	2020	1.26	1.32	0.73
	2025	1.80	1.86	1.10
	2030	2.51	2.58	1.60
Attached/Row Houses	2015	0.70	0.71	0.44
	2020	0.83	0.84	0.53
	2025	0.99	1.01	0.65
	2030	1.18	1.19	0.78
Mobile/Other	2015	0.68	0.69	0.47
	2020	0.74	0.75	0.52
	2025	0.80	0.81	0.58
	2030	0.87	0.88	0.63
Seasonal & Garage	2015	0.12	0.13	0.05
	2020	0.11	0.12	0.04
	2025	0.10	0.11	0.04
	2030	0.08	0.09	0.03
Small Grid Housing	2015	0.07	0.07	0.04
	2020	0.07	0.07	0.05
	2025	0.07	0.08	0.05
	2030	0.07	0.08	0.05
Sentinel Lighting	2015	0.03	0.03	0.03
	2020	0.03	0.03	0.03
	2025	0.03	0.03	0.03
	2030	0.03	0.03	0.03
Grand Total	2015	9.96	10.11	6.43
	2020	11.33	11.46	7.48
	2025	13.02	13.12	8.75
	2030	14.95	15.03	10.21

Exhibit 38 Electric Peak Load Reductions from Economic Energy Savings Measures, by Milestone Year Dwelling Type and End Use, Annual Peak Hour (MW)

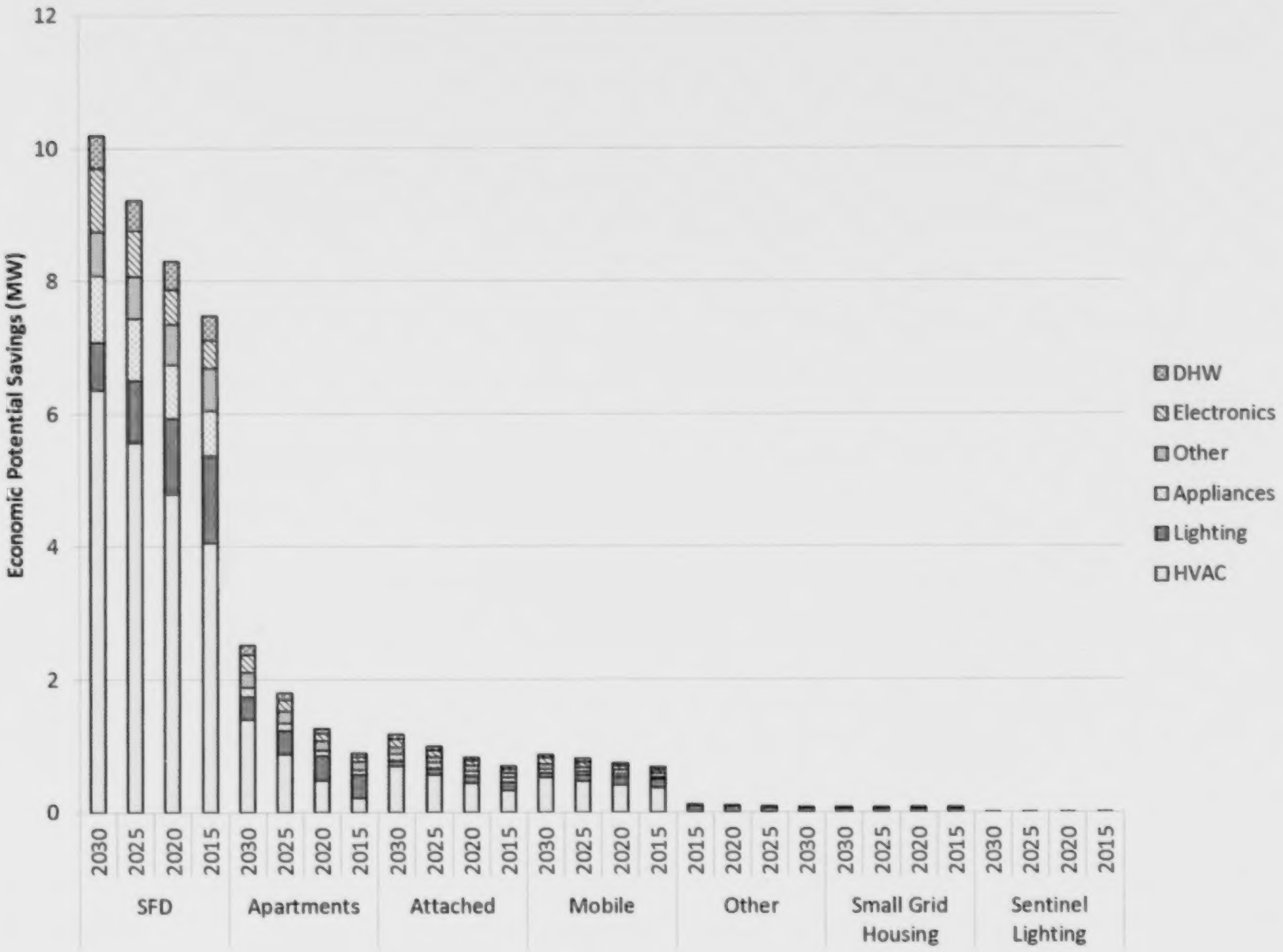


Exhibit 39 Electric Peak Load Reductions from Economic Energy Savings Measures, 2030 (MW)

Measure	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Block Heater Timers	2.587	3.234	0.000
High-Perf. New Homes	2.499	2.452	1.797
Zone Heating	1.915	1.878	1.237
LEED Apartments	1.287	1.278	0.853
ESTAR Clothes Washers	1.216	1.039	0.544
CFLs - Indoor	0.838	0.931	0.372
Wall Insulation	0.687	0.672	0.462
Future Elec Improvement	0.582	0.584	0.430
Power Bars (PCs)	0.377	0.386	0.283
Outdoor Temp Reset	0.330	0.324	0.214
Sealing & Insul. - Old Homes	0.268	0.262	0.180
Attic Insulation	0.257	0.251	0.172
Power Bars (TVs)	0.223	0.220	0.162
ESTAR Refrigerators	0.183	0.173	0.138
Air Sealing	0.175	0.171	0.119
DHW Recirculation	0.151	0.168	0.428
ESTAR TVs	0.141	0.140	0.103
ESTAR Printers and Fax	0.126	0.129	0.094
Dimmable CFLs	0.121	0.135	0.054
DHW Piping Optimization	0.117	0.131	0.334
Prog. Thermostats (Central)	0.116	0.113	0.077
Triple-glazed Windows	0.108	0.105	0.072
Ground Heat Pumps - Closed	0.104	0.102	0.071
PAR CFLs	0.104	0.116	0.046
Car Warmer Timers	0.099	0.124	0.000
Solar Pre-heat Makeup Air	0.096	0.094	0.063
Wastewater Heat Recovery	0.095	0.106	0.271
LED Lamps	0.083	0.092	0.037
Prog. Thermostats	0.078	0.076	0.052
Battery Blanket Timers	0.076	0.095	0.000
Furnace Motors	0.073	0.068	0.067
T8 Fixtures	0.063	0.070	0.028
ESTAR Freezers	0.059	0.056	0.044
Showerheads	0.057	0.064	0.162
ESTAR Dishwashers	0.048	0.058	0.107
Heat Pump Spa Heaters	0.044	0.042	0.041
Optimizing Glazing for Passive	0.042	0.041	0.028
Hot Tub Pump Timers	0.038	0.036	0.036
DHW Tank Insulation	0.034	0.038	0.098
Pulse start metal halide sentinel lights	0.032	0.030	0.033
Basement Insulation	0.030	0.029	0.020
Slab Insulation	0.028	0.027	0.019
DHW Pipe Insulation	0.027	0.030	0.077
HRVs	0.026	0.026	0.018
LED Holiday - Outdoor	0.020	0.020	0.000
Spa Pumps	0.018	0.017	0.017
Quadruple-glazed Windows	0.016	0.016	0.011
LED Holiday - Indoor	0.014	0.014	0.000
Spot or Task Lighting	0.013	0.015	0.006
Solar Spa Pre-heat	0.012	0.012	0.012
Motion Detectors - Indoor	0.011	0.013	0.005
CFLs - Outdoor	0.008	0.007	0.008
Motion Detectors - Outdoor	0.007	0.007	0.008
Hot Tub Covers	0.003	0.003	0.003
Crawl Space Insulation	0.002	0.002	0.002
Grand Total	15.768	16.324	9.512

9 Technology Assessment: Peak Load Measures

9.1 Introduction

This section identifies and assesses the economic attractiveness of selected Residential sector electric capacity-only peak load reduction measures, which in this study are defined as those measures that affect electric peak but have minimal or no impact on daily, seasonal or annual electric energy use. The discussion is organized and presented as follows:

- Methodology
- Electric peak load reduction measures
- Summary of results.

9.2 Methodology

The following steps were employed to assess the peak load reduction measures:

- Select candidate peak load reduction measures
- Establish technical performance for each option
- Establish the capital, installation and operating costs for each option
- Calculate the cost of electric peak load reduction (CEPR) for each option.

A brief description of each step is provided below.

Step 1 Select Candidate Measures

The candidate measures were selected in close collaboration with YEC, YECL and Government of Yukon personnel based on a combination of a literature review and previous study team experience. The selected measures are all considered to be technically proven and commercially available, even if only at an early stage of market entry. Technology costs, which will be addressed in this section, were not a factor in the initial selection of candidate technologies.

Step 2 Establish Technical Performance

Information on the performance improvements provided by each measure was compiled from available secondary sources, including documented experience and on-going research work by other utilities and study team members. In some cases, comfort may be affected and the trade-off between benefits (e.g., cost savings) and costs (including reduction in comfort) were judged based on past experience with similar technologies and customer acceptance.

Step 3 Establish Capital, Installation and Operating Costs for Each Measure

Information on the cost of implementing each measure was also compiled from secondary sources, including the experience and on-going research work of study team members.

Unlike energy-efficiency measures, in which major equipment, such as heating and water heating systems are typically replaced, or thermal envelope measures such as insulation upgrades affect systems directly, capacity-only measures are typically implemented via add-on control equipment, although some built-in control equipment exists. The incremental cost is thus defined as the control equipment itself or incremental cost for a controllable appliance or device relative to the baseline appliance cost (e.g., remote accessible thermostat vs. standard thermostat), plus any required infrastructure (e.g., automatic meter reading or communications gateways). In cases where a more efficient appliance with peak control functions replaces a standard appliance, both electric energy and electric peak reduction are achieved, with some splitting of incremental costs attributable to each function. Where a new or replacement end use is installed that operates off peak, thus achieving electric peak reduction without significant energy impacts, incremental costs for the electric peak reduction device will be compared with standard equipment without assuming any early replacement and, thus, salvage value.

In all cases, the costs and savings are annualized, based on the number of years of equipment life and the discount rate. The costs incorporate applicable changes in annual O&M costs and all costs are expressed in constant (2010) dollars.

Step 4 Calculate CEPR for Each Measure

The CEPR for a peak load reduction measure is defined as the annualized incremental cost of the measure divided by the annual peak reduction achieved, excluding any administrative or program costs required to achieve full use of the technology or measure. All cost information presented in this section and in the accompanying tables (see Appendix G) is in constant (2010) dollars.

The CEPR provides a basis for the subsequent selection of measures to be included in the Economic Potential Forecast (see Section 8). The CEPR is calculated according to the following formula:

$$\frac{C_A + M}{S_p}$$

Where:

CA is the annualized installed cost
M is the incremental annual cost of operation and maintenance (O & M)
S p is the annual kW load reduction associated with peak definition p.
And A is the annualization factor.

$$A = \frac{i(1+i)^n}{(1+i)^n - 1}$$

Where:i is the discount rate; n is the life of the measure.

Note that the annual O&M cost will include, in some cases, amortized costs associated with infrastructure considered a prerequisite for implementation of the measure. This could include automated metering infrastructure (AMI), such as advanced metering, communications gateways and other related system investments. These costs would typically support multiple applications (e.g., communications gateways could enable control of heating, air conditioning, water heating, pool pumps, spas and small appliances), as well as facilitate time-differentiated rates that would be required for a feasible and cost-effective program implementation (e.g., thermal energy storage). It should also be noted that the measure lifetime is for the control device, function or feature, rather than that of the unit it is controlling. The study does not presume any specific technology or infrastructure, but does assume that a marketplace will develop for such systems, whether or not Yukon utilities adopt them, or develops access directly or indirectly to customer control equipment.

The CEPR can be compared to benefits, which include the value of reduced peak for the utility (avoided capacity and transmission and distribution (T&D) investment or purchase costs), the customer (e.g., bill savings) and society (e.g., value of environmental benefits) to determine its cost effectiveness from various perspectives (societal, utility, participant and non-participant).

As with the CCE for energy savings, the CEPR calculation is sensitive to the chosen discount rate, which, as for the CCE, used a 5.25% (real) discount rate. Higher discount rates will tend to reduce savings and decrease cost effectiveness where costs are incurred upfront and benefits accrue over many years.

9.3 Electric Peak Reduction Measures

The selected electric peak load reduction measures are presented in Exhibit 40. It should be noted that some measures included in Exhibit 40 could be implemented as behavioural in the short term, until—and if—the technology to automate these measures becomes cost effective. For example:

- A utility program that appeals to customers to conserve on a particular day or span of hours could be implemented as a behavioural measure where customers voluntarily shut off unnecessary lights manually.
- Similarly, home automation devices now available would enable customers to shut selected lights automatically or even remotely on demand.
- Finally, utility access, via communications with in-home control systems could enable utilities to shut devices, with customer approval, remotely during system critical times. This approach is often done using remote thermostat control systems for heating and cooling.

Thus, some measures identified in Exhibit 40 as technical potential may be initially implemented as behavioural and evolve into technical measures as technology and economics advance.

Exhibit 40 Summary of Residential Electric Peak Load Reduction Measures

Residential End Use	Capacity-only Measure	Description	Applicability of Measures By Sub sector
Water heating	Switch-based water heating unit control	Control switch installed on water heating system circuits or unit for remote shut off or cycling control (typically utility controlled)	Electric water heating with separate tanks
Engine block heaters	Switch-based timer control	Remote control switch activated by utilities to force unit operation (with or without timers) to avoid system peak period	All
Lighting	Non-essential lighting control	Control switch installed on non-essential lighting plug loads and circuits (e.g., holiday lights) for utility control during system critical events	All

Residential End Use	Capacity-only Measure	Description	Applicability of Measures By Sub sector
Multiple (whole house)	Voluntary remote plug load control	Switches on voluntary, non-essential plug loads for utility control during system critical events (e.g., clothes washers, clothes dryers, dishwashers, computers, peripherals, set-top boxes, electronics chargers, pool/spa heaters), remotely controlled with plug switches – can be locally overridden	All customers – facilitated by time-of-use rates and/or critical peak rate structure
Space heating	Electric thermal storage (ETS)	ETS units to replace electric supplemental units	Dwelling units with electrical supplemental heating

9.4 Technology Screening Results

A summary of the results is provided in Exhibit 41. For each of the measures reviewed, the exhibit shows:

- The name of the measure
- The cost basis for the CEPR that is shown, e.g., full versus incremental
- The measure's average CEPR.

Measures analyzed on the basis of full cost have been placed towards the top of Exhibit 41 as they are qualitatively different from the measures that pass only on an incremental basis. A measure that passes on a full-cost basis can be applied immediately, while incremental measures presume the adoption of other technologies as a condition of their cost effectiveness (e.g., home area network gateways).

Exhibit 41 Residential Sector Electric Peak Load Reduction Measures, Screening Results

Measure Name	Basis (Full/Incremental)	CEPR Ranges ($/kW)
One-way switch for engine block heater	Full	$52 - $65
Electric central thermal storage	Full	$99 – $101
One-way switch for pools and spas	Full	$72 - $77
One-way switch for water heating control	Full	$83 - $106
Electric room thermal storage for supplemental heat	Full	$85 - $87
One-way switch for plug loads	Full	$168 - $229
One-way switch for lighting control	Full	$256 - $285
One-way switch for engine block heater	Incremental	$45 - $56
One-way switch for pools and spas	Incremental	$34 - $36
One-way switch for plug loads	Incremental	$47 - $64
One-way switch for lighting control	Incremental	$73 - $81
One-way switch for water heating control	Incremental	$73 - $81

9.5 Electric Peak Supply Curves

A supply curve was constructed based on the approximate Economic Potential savings associated with the above measures. The following approach was used:

- Measures are introduced in sequence to show incremental impact and cost
- Sequence was determined by listing the items that reduce the electrical peak first, then those that meet residual load with the most efficient technology
- Items appear in order, beginning with those that have the lowest average CEPR.

Exhibit 42 shows the measures included in the supply curve. Exhibit 43 and Exhibit 44 show the supply curves under two scenarios: with and without existing gateways.

Note that since there was no threshold established for maximum cost effectiveness, all measures are listed and there are no exclusions based on lack of cost effectiveness.

Exhibit 42 Total Applicable Dwelling Types and MW Impact by Measure

Electric Peak Reduction Measures	Dwelling Saturation	Applicable Count 2010	Avg MW	Avg CEPR $/kW/yr.
Space Heating				
One-way switch for engine block heater - utility load control – stand-alone	65%	10,172	2.0	$52 - $65
One-way switch for engine block heater - utility load control - incremental	65%	10,172	2.0	$45 - $56
Electric thermal storage (central)	14%	2,180	6.9	$99 - $101
Electric thermal storage (room/supplemental)	8.9%	1,384	1.7	$85 - $87
Electric Water Heating				
One-way switch-based utility load control – stand-alone	73%	11,326	2.9	$100-$112
One-way switch-based utility load control - incremental	73%	11,326	2.9	$73 - $81
Lighting				
One-way switch-based utility load control - stand-alone	100%	14.622	1.3	$256 - $285
One-way switch-based utility load control - incremental	100%	14.622	1.3	$73 - $81
Plug Loads				
One-way switch-based utility load control - stand-alone	100%	14,622	1.0	$168 - $229
One-way switch-based utility load control – incremental	100%	14,622	1.0	$47 - $64
Electric Pools and Spas				
One-way switch-based utility load control - stand-alone	7.2%	1,120	0.7	$72 - $77
One-way switch-based utility load control – incremental	7.2%	1,120	0.7	$34 - $36

The supply curves below illustrate the cumulative electric peak load reduction available based on two scenarios. Scenario 1 (Exhibit 43) assumes that each measure cost would require new installation of gateways for communications between utility and devices, i.e., no existing communications gateways are in place. Scenario 2 (Exhibit 44) assumes that there are existing gateways so only incremental costs for additional control devices would be included.

Exhibit 43 Cumulative Supply Curve Including Gateway Costs

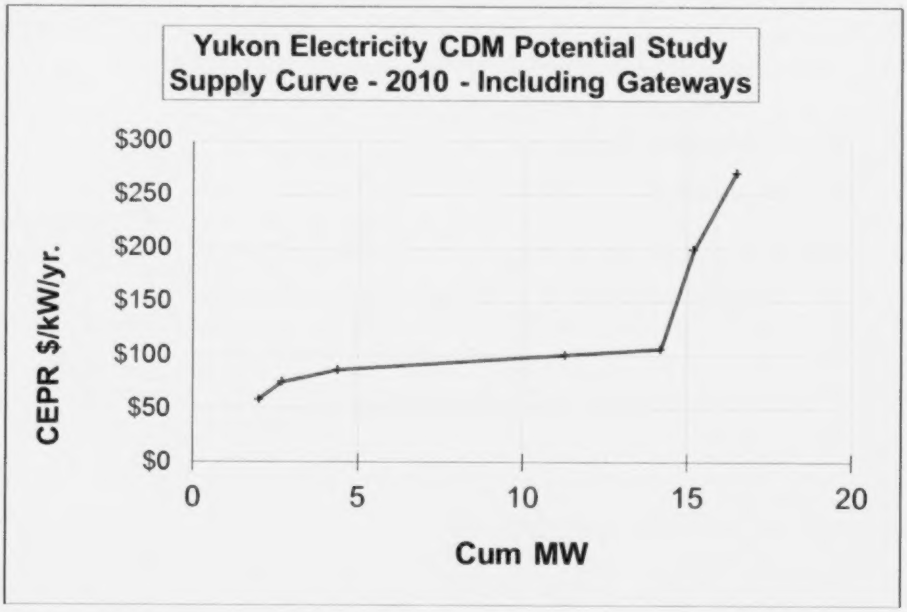
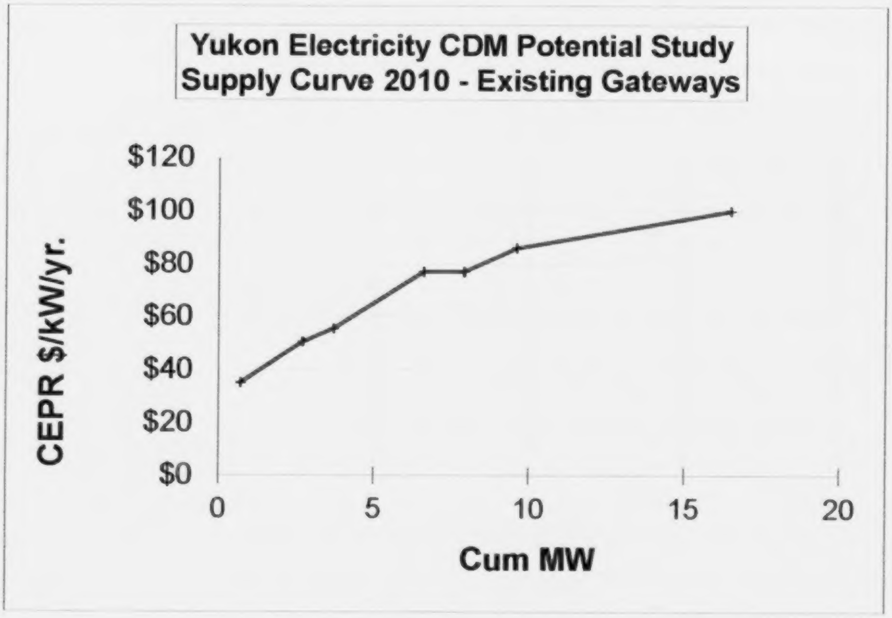


Exhibit 44 Cumulative Supply Curve with Existing Gateways (no cost)



As illustrated, without existing gateways, about 14 MW are technically available for under $106/kW/yr., after which another 3 MW (17 MW total) would be available for under $256/kW/yr. With existing gateways in place, approximately 10 MW would be available for under $90/kW/yr. and all 17 MW available for under $100/kW/yr.

It should be noted that there is a point beyond which electric peak load reductions, defined in terms of the Annual Peak Hour (6 pm on system peak day), become uneconomic if they result in the creation of a new peak after those time periods as a result of deferral of the loads during the peak until other periods, such as immediately following the peak period.

In theory, this concept is applicable. However, in practice (i.e., applying Achievable Potential), it is highly unlikely that the saturation of electric peak load measures would be sufficient to cause such a shift. The application of electric thermal storage (ETS) would be the type of electric peak load measure that would have the greatest potential to create a new (later) peak if the full off-peak charging operation of the units were implemented immediately after the end of the peak period. As a result, it has been assumed that the off-peak charging period would begin at 11 pm, rather than earlier, such as 9 pm, right after the Evening Peak ends. For both space and water heating load control, it would be expected that some degree of "recovery" would follow load control periods in order to restore the temperature of the air/water to the pre-determined comfort levels. For lighting, plug loads and pool pumps/spas, the "recovery" would be minimal to negligible.

10 Achievable Potential: Electric Energy Forecast

10.1 Introduction

This section presents the Residential sector Achievable Potential for the study period (2010 to 2030). The Achievable Potential is defined as the proportion of the energy-efficiency opportunities identified in the Economic Potential Forecast that could realistically be achieved within the study period.

The remainder of this discussion is organized into the following subsections:

- Description of Achievable Potential
- Approach to the estimation of Achievable Potential
- Results – energy-efficient technologies.

10.2 Description of Achievable Potential

Achievable Potential recognizes that, in many instances, it is difficult to induce all customers to purchase and install all the energy-efficiency technologies that meet the criteria defined by the Economic Potential Forecast. For example, customer decisions to implement energy-efficient measures can be constrained by important factors such as:

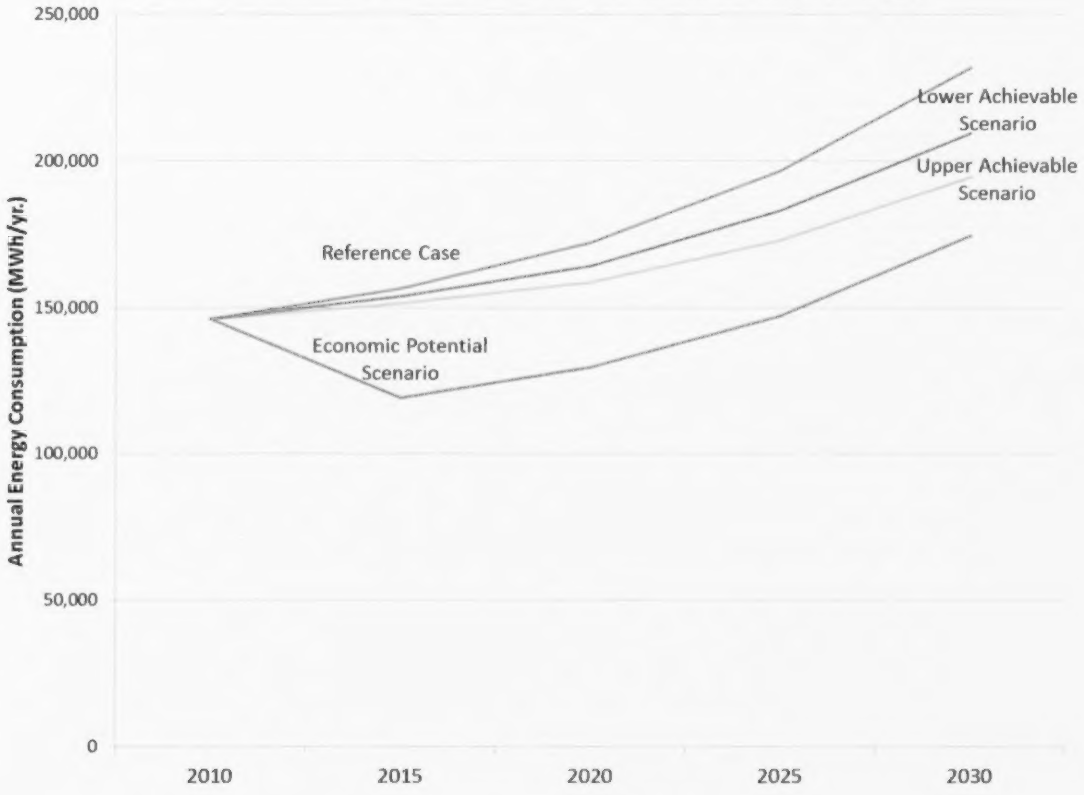
- Higher first cost of efficient product(s)
- Need to recover investment costs in a short period (payback)
- Lack of product performance information
- Lack of product availability.

The rate at which customers accept and purchase energy-efficiency products will be influenced by the level of financial incentives, information and other measures put in place by YECL, YEC, the Government of Yukon, other levels of government, and the private sector to remove barriers such as those noted above.

Exhibit 45 presents the levels of electricity consumption that are estimated in the Achievable Potential scenario. As illustrated, the Achievable Potential scenarios are banded by the two forecasts presented in previous sections: the Economic Potential Forecast and the Reference Case.

As illustrated in Exhibit 45 electric energy savings under the Achievable Potential scenario are less than in the Economic Potential Forecast. In this CPR, the primary factor that contributes to the outcome shown in Exhibit 45 is the rate of market penetration. In the Economic Potential Forecast, efficient new technologies are assumed to fully penetrate the market as soon as it is economically attractive to do so. However, the Achievable Potential recognizes that under real world conditions, the rate at which customers are likely to implement new technologies will be influenced by additional practical considerations and will, therefore, occur more slowly than under the assumptions employed in the Economic Potential Forecast.

Exhibit 45 Annual Electricity Consumption—Energy-efficiency Achievable Potential Relative to Reference Case and Economic Potential Forecast for the Residential Sector, (MWh/yr.)



As also illustrated in Exhibit 45 the Achievable Potential results are presented as a band of possibilities, rather than a single line. This is because any estimate of Achievable Potential over a 20-year period is necessarily subject to uncertainty. Consequently, two Achievable Potential scenarios are presented: lower and upper.

The lower Achievable Potential assumes Yukon market conditions that are similar to those contained in the Reference Case. That is, the customers' awareness of energy-efficiency options and their motivation levels remain similar to those in the recent past, technology improvements continue at historical levels, and new energy performance standards continue as per current known schedules. It also assumes that the ability of the Yukon utilities and government to influence customers' decisions towards increased investments in energy-efficiency options remains roughly in line with previous company DSM experience.

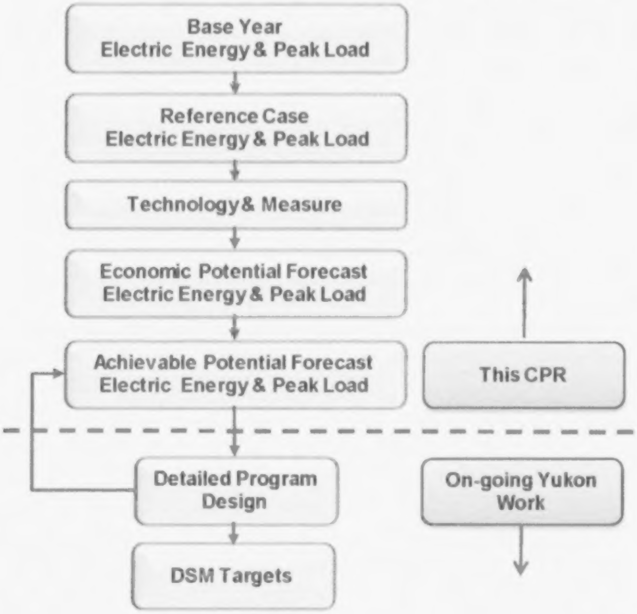
The upper Achievable Potential assumes Yukon market conditions that aggressively support investment in energy efficiency. For example, this scenario assumes that real electricity prices increase over the study period. It also assumes that federal and territorial government actions to mitigate climate change result in increased levels of complementary energy-efficiency initiatives. The upper Achievable Potential typically does not reach economic potential levels; this recognizes that some portion of the market is typically constrained by barriers that cannot realistically be affected by DSM programs within the study period.

10.2.1 Achievable Potential Versus Detailed Program Design

It should also be emphasized that the estimation of Achievable Potential is not synonymous with either the setting of specific program targets or with program design. While both are closely linked to the discussion of Achievable Potential, they involve more detailed analysis that is beyond the scope of this study.

Exhibit 46 illustrates the relationship between Achievable Potential and the more detailed program design.

Exhibit 46 Achievable Potential versus Detailed Program Design


Base Year
Electric Energy & Peak Load
Reference Case
Electric Energy & Peak Load
Technology & Measure
Economic Potential Forecast
Electric Energy & Peak Load
Achievable Potential Forecast
Electric Energy & Peak Load
This CPR
Detailed Program Design
On-going Yukon Work
DSM Targets

This study examined more than 60 technologies applicable to residential electric end uses. Although considerable effort has been made to obtain up-to-date information on each technology and to tailor it to the local market in Yukon, this is not a substitute for the type of detailed groundwork needed to prepare a utility program. For each of the technologies selected for further investigation, it will be important to obtain further information on the technical viability and durability of the products in the Yukon climate, on the costs in the Yukon marketplace, and on real savings under local conditions. If the viability of the technology is confirmed, an assessment of the market barriers is required, leading to the development of program strategies to overcome these barriers.

10.3 Approach to the Estimation of Achievable Potential

Achievable Potential was estimated in a five-step approach.

- Priority opportunities were selected
- Opportunity profiles were created
- Opportunity worksheets were prepared

- A full-day workshop was held
- Workshop results were aggregated and applied to the remaining opportunities.

Further discussion is provided below.

Step 1 Select Priority Opportunities

The first step in developing the Achievable Potential estimates required selection of the energy-saving opportunities identified in the Economic Potential Forecasts to be discussed during the Achievable workshop. Several criteria determined selection, including:

- The priority measures should represent a substantial fraction of the overall economic potential
- The priority measures should represent several different energy end uses
- The priority measures should have a variety of different likely patterns of market adoption, so the discussions will be widely varied.

A summary of the selected energy-efficiency actions, along with the approximate percentage that it represents in the Economic Potential Forecast, is provided in Exhibit 47.[26]

Exhibit 47 Residential Sector Actions – Energy Efficiency

Measure #	Measure	End Use	Fraction of 2030 Economic Potential (%)
R1	ESTAR Clothes Washers	Washers, Dryers, & DHW	10%
R2	Block Heater Timers	Block heaters & car warmers	2%
R3	Power Bars (PCs)	Computer and peripherals	4%
R4	LED Lamps	Lighting	1%
R5	DHW Recirculation	Space heating	3%
F6	Wall Insulation	DHW	3%
R7	Cold Temp Heat Pumps	HVAC & DHW	9%
R8	High-Perf. New Homes	Space heating	13%
R9	Sealing & Insul. - Old Homes	Space heating	1%
R10	ESTAR TVs	Television	2%
Grand Total			48%

Step 2 Create Opportunity Assessment Profiles

The next step involved the development of brief profiles for each of the opportunities noted above in Exhibit 47, in the form of PowerPoint slides. The slides are presented in Appendix H.

The purpose of the opportunity profiles was to provide a high-level logic framework that would serve as a guide for participant discussions in the Achievable workshop (see Step 4 below). The intent was to define a broad rationale and direction without getting into the much greater detail required of program design, which, as noted previously, is beyond the scope of this project. As illustrated in Appendix H, each opportunity profile addresses the following areas:

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[26] Measures R9 and R10 were not discussed in the workshop. In a one-day workshop of this type there is normally time to discuss eight energy-efficiency actions. Two additional measures were included in case there was extra time.

- Technology Description – provides a summary statement of the broad goal and rationale for the action.

- Target Dwelling Type and Typical Application — highlights the dwelling types and applications offering the most significant opportunities, and which provide a good starting point for discussion of the technology.

- Financial and Economic Indicators — provides estimates of average simple payback, cost of conserved electricity (CCE) and basis of assessment (full-cost versus incremental).
- Eligible Participants — provides an estimate of the number of dwellings or appliances that could be affected during the study period if the entire Economic Potential were to be captured.

- Economic Potential versus Time — shows the pattern of the changing size of the opportunity over the study period, for existing and new dwellings. Some opportunities grow steadily through the study period, as more and more appliances reach the age when they would be replaced. Other opportunities are economic to capture immediately, and after that the growth over time is limited to opportunities in new dwellings being built. Still other opportunities decline with time as they are eroded by natural conservation activities.

Step 3 Prepare Opportunity Worksheets

A draft assessment worksheet was also prepared for each opportunity profile in advance of the Achievable workshop. The assessment worksheets complemented the information contained in the opportunity profiles by providing quantitative data on the potential electric energy savings for each opportunity as well as providing information on the size and composition of the eligible population of potential participants. Energy impacts and population data were taken from the detailed modelling results contained in the Economic Potential Forecast.

The worksheets, including the results recorded during the workshop discussions, are provided in Appendix I. As illustrated in Appendix I, each opportunity assessment worksheet addresses the following areas:

- Approximate Cost of Conserved Electricity — shows the approximate levelized cost of saving each kWh of electricity saved by the measure. For the purposes of the workshop, this information provided participants with an indication of the scope for using financial incentives to influence customer participation rates.

- Customer Payback — shows the simple payback from the customer's perspective for the package of energy-efficiency measures included in the opportunity. This information provided an indication of the level of attractiveness that the opportunity would present to customers. This provided an important reference point for the workshop participants when considering potential participation rates. When combined with the preceding CCE information, participants were able to roughly estimate the level of financial incentives that could be employed to increase the opportunity's attractiveness to customers without making it economically unattractive to the Yukon utilities.

- **Economic Potential in Terms of Applicable Participants (e.g., number of dwellings)** — shows the total number of potential participants in terms of either dwellings or appliances (as appropriate) that could theoretically take part in the opportunity. Numbers shown are from the eligible populations used in the Economic Potential Forecasts.

- **Participation Rates (%)** — these fields were filled in during the workshops (described below in the following step), based on input from the participants. They show the percentage of economic savings that workshop participants concluded could be achievable in the last milestone period (usually 2030, but may be earlier for measures that peak earlier).

- **Achievable Potential in Terms of Applicable Participants (e.g., number of dwellings)** — these fields were calculated by the spreadsheet based on the participation rates provided by the participants.

- **Participation Rates Relative to the Discussion Scenario** — these fields were filled in during the workshops to provide guidance to the consulting team on how participation might differ in other regions or dwelling types, or for related or similar technologies.

- **Other Parameters** — these fields were filled in during the workshop to capture highlights of the discussion.

Step 4 Conduct Achievable Workshop

The most critical step in developing the estimates of Achievable Potential was a one-day Achievable Potential workshop that was held on November 15, 2011. Workshop participants consisted of core members of the consultant team, DSM program and technical personnel from YECL, YEC and the Government of Yukon, industry representatives, and representatives of other stakeholders. Together, the participating personnel brought many years of experience to the workshop related to the technologies and markets.

The purpose of this workshop was to:

- Promote discussion regarding the technical and market constraints confronting the identified energy-efficiency opportunities
- Identify potential strategies for addressing the identified constraints, including potential partners and delivery channels
- Compile participant views related to how much of the identified economic savings could realistically be achieved over the study period.

Following a brief consultant presentation that summarized the Residential sector study results to date, the workshop provided a structured assessment of each of the selected opportunities. Opportunity assessment consisted of a facilitated discussion of the key elements affecting successful promotion and implementation of the DSM opportunity. More specifically:

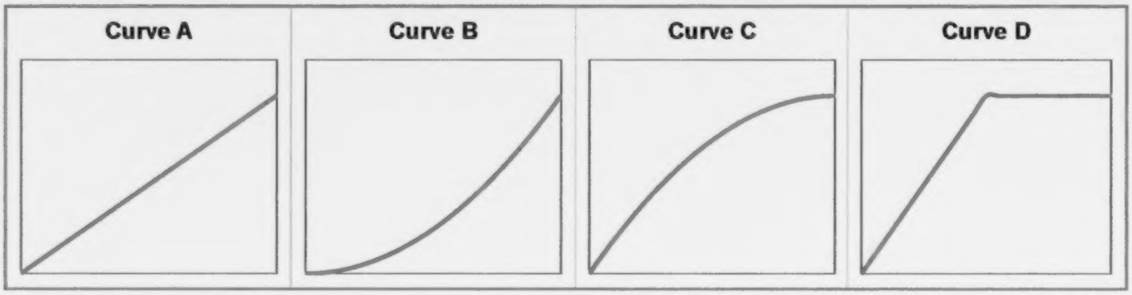
- What are the major constraints/challenges constraining customer adoption of the identified energy-efficiency opportunities?
  - How big is the "won't" portion of the market for this opportunity?
- Preferred strategies and potential partners for addressing the identified constraints (high level only)
  - Key criteria that determine customers' willingness to proceed

- Key potential channel partners
- Optimum intervention strategies e.g., push, pull, combination
- How sensitive is this opportunity to incentive levels?

Following discussion of market constraints and potential intervention strategies, the participants' views on potential participation rates were recorded. The process involved the following steps:

- The participation rate for the upper Achievable scenario in 2030 was estimated.
- The shape of the adoption curve was selected for the upper Achievable scenario. Rather than seek consensus on the specific values to be employed in each of the intervening years, workshop participants selected one of four curve shapes that best matched their view of the appropriate "ramp-up" rate for each opportunity (see Exhibit 48 below).
- The process was then repeated for the lower Achievable scenario.
- Once participation rates had been established for the specific technology, sub sector and service region selected for the opportunity discussion, workshop participants provided the consultants with guidelines for extrapolating the discussion results to the other sub sectors and service regions included in the opportunity, but not discussed in detail during the workshop. Where time permitted, participants also discussed how the adoption of similar, related technologies might differ from the technology being discussed.

Exhibit 48 Participation Rate "Ramp Up" Curves



Curve A represents a steady increase in the expected participation rate over the study period

Curve B represents a relatively slow participation rate during the first half of the study period followed by a rapid growth in participation during the second half of the 20-year study period

Curve C represents a rapid initial participation rate followed by a relatively slow growth in participation during the remainder of the study period

Curve D represents a very rapid initial participation rate that results in virtual full saturation of the applicable market during the first half of the study period.

Step 5 Aggregate and Extend Opportunity Results

The final step involved aggregating the results of the individual opportunities to provide a view of the potential Achievable in both the Residential and Commercial sectors.

10.4 Achievable Workshop Results

The following sub sections present a summary of the workshop discussions for each of the residential opportunities listed in Exhibit 47 above. The adoption rates and curves selected by the participant are summarized in Section 10.4.9. Included for each opportunity are:

- Participation estimates (for 2030) made by workshop participants, with comments, where needed, about values assumed in the calculations (presented in Section 10.5)
- Where needed, additional participation estimates made after the workshop for the purposes of the calculations (presented in Section 10.5)
- Selected highlights that attempt to capture key discussion themes related to the opportunity.

Appendix I provides copies of the assessment worksheets used during the workshop.

10.4.1 ENERGY STAR® Clothes Washers

Achievable workshop participants provided 2030 participation rate estimates of 80% for the upper Achievable Potential scenario and 65% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve in the upper Achievable Potential scenario would be C, while in the lower Achievable Potential scenario it would most likely be B.

Barriers that tend to lower adoption included the split incentives that operate in rental housing situations, and the high first-cost barrier in the lower income market. There is an active market in used appliances – the incremental cost from a used clothes washer to a new high-efficiency model is very large. There may be some disincentive for people to invest in more expensive clothes washers because of the relatively short time people tend to stay in the same home in Yukon, and the tendency to sell the major appliances along with the home.

Potential strategies for addressing the market barriers include working with the retailers, offering incentives to sales people or point-of-sale rebates, and working with important partners, such as municipalities, the Yukon Energy Solutions Centre, First Nations, and the Yukon Housing Corporation. The water conservation aspect of the efficient washers will be important in some communities, and some municipalities may be willing to include washer performance standards in their sewer/water bylaws. Education to both retailers and consumers is potentially an important element in programs, to overcome reluctance to adopt a new technology.

The initial discussion focused on existing single detached homes on the hydro grid. Participants believed participation would be somewhat lower in apartments and somewhat higher in new homes. In Old Crow and the small diesel communities, participation would be lower because of the difficulty of transporting the appliances to those communities. Participants also discussed some of the other large appliance measures briefly. Adoption of refrigerators was thought likely to proceed somewhat more slowly than adoption of clothes washers, while dishwashers were thought likely to be adopted more quickly.

10.4.2 Block Heater Timers

Achievable workshop participants provided 2030 participation rate estimates of 70% for the upper Achievable Potential scenario and 50% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve in the upper Achievable Potential scenario would be a shallow version of B (halfway between A and B), while in the lower Achievable Potential scenario it would most likely be B.

Barriers that tend to lower adoption included concerns about the usability of the product – difficulty of programming, risk of failure in the event of a power outage or surge, and the high cost of failure in the event that the timer failed to turn the block heater on at the right time. Many people do not know about or believe the evidence that after four hours a block heater is no longer raising the temperature of the engine block. Consumers also do not consider the savings from block heater timers to be significant. Some people have jobs that require them to be "on call" and therefore they do not have the option of using a block heater timer. There is some concern that the block heater timers currently on the market may not have all the quality and features needed for use in Yukon. Some product testing may be required.

The block heater timer offers disproportionately large peak demand reduction opportunities compared to its electric energy savings. As a measure, it therefore likely has greater value to the utilities than its capital cost. Nonetheless, any direct rebates on the block heater itself should not be sufficient to reduce the consumer's cost to zero – people may not see its value if it costs them nothing. More important elements of a program will likely include educational materials, media communications, testimonials, point-of-sale materials, and bundling of other products with the block heater. In new homes, block heater controls can be built into a control switch inside the house. Program activity could also include programming the timers for people, and following up to make sure they are working well. Possibly the most important initial activity may be product testing, to determine whether there are adequate products for the Yukon market.

Block heater timers offer very significant peak reduction potential for relatively small cost. This leaves a lot of room for spending on program support for them. Testing will be needed to make sure there are products suitable for the Yukon.

The initial discussion focused on existing single detached homes on the hydro grid. Participants believed participation would be somewhat lower in apartments. Participants also discussed some of the other measures in the "miscellaneous" categories. Timers for car warmers and battery blankets were expected to be adopted at a rate similar to that of block heater timers. Measure affecting spas were thought likely to be adopted somewhat slower.

10.4.3 Power Bars (PCs)

Achievable workshop participants provided 2030 participation rate estimates of 40% for the upper Achievable Potential scenario and 20% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve for both scenarios would be a shallow version of B (halfway between A and B).

Barriers that tend to lower adoption included technical concerns about programming the devices, as well as the inconvenience of timing out the computer in communities where internet access is slow. Some power bars lack a battery backup to preserve the programming in the event of a power outage. Power bars also must incorporate surge protection. People are aware of the issue of phantom loads but it is not a high priority for them. There is some concern that the power bars currently on the market may not have all the quality and features needed for use in Yukon. Some product testing may be required.

There is some reduction in the potential as more people move from desktop computers to laptops. In addition, manufacturers are likely to incorporate better phantom load management in computers and other electronics products, eventually reducing the potential contribution of smart power bars.

Strategies to encourage adoption of power bars would likely include partnerships with retailers, case studies of early adopters, and media communication. Education of consumers and retailers would also be important. Power bars could also be bundled with other measures. Information technology (IT) departments could be important partners; in addition to using the smart power bars in people's workplaces, the IT department could be a point of contact for encouraging people to use them at home. Possibly the most important initial activity may be product testing, to determine whether there are adequate products for the Yukon market.

The initial discussion focused on existing single detached homes on the hydro grid. Participants believed participation would be somewhat lower in homes on the diesel grids, because of the difficulty of obtaining the products in those communities. Participants also discussed some of the other electronics measures. Power bars for televisions were expected to be adopted at the same rate as power bars for computers. ENERGY STAR® televisions, printers, and faxes were expected to be adopted at similar rates to ENERGY STAR® large appliances.

The measure titled "Future Electronics Improvements" was included in the study as a placeholder to capture the need for North American utilities to work with electronics manufacturers to address the growing electricity consumption from electronics in homes.

10.4.4 LED Lamps

Achievable workshop participants provided 2030 participation rate estimates of 85% for the upper Achievable Potential scenario and 70% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve both scenarios would be B.

Barriers that tend to lower adoption included technical concerns about light quality or radio frequency interference. The first cost of the products is high and there are not currently products available for all applications. LED lighting is currently financially competitive with incandescent lights, but is not as financially attractive as compact fluorescent lamps. Performance and cost are both improving rapidly, however, and by as early as 2020 this may have changed. LED products are not currently available in the market for some applications. Some product testing would help identify applications for which there are suitable products.

Strategies to encourage adoption of LED lighting could include qualification of products based on performance standards, including light quality and radio frequency interference standards. Educational materials could focus on the superiority of LEDs over compact fluorescents; many consumers prefer the quality of light from LEDs compared to compact fluorescents, and they do not have the same mercury disposal problems. Possibly the most important initial activity may be product testing, to determine what products are available and for what applications.

The initial discussion focused on existing single detached homes on the hydro grid. Participants believed participation would be somewhat lower in homes on the diesel grids because of the difficulty of obtaining the products in those communities. Participants also discussed some of the other lighting measures. Compact fluorescent lamps were expected to offer only limited opportunities for further adoption. There are no recycling facilities for them in Yukon, so people are reluctant to incur the disposal problem.

10.4.5 Wall Insulation

Workshop participants were more interested in discussing a "deep retrofit" approach rather than the doubling of wall insulation levels originally proposed as the measure to discuss. The deep retrofit involves adding approximately R-40 (RSI 7) to the outside of the walls. This deeper measure does pass the economic screen, so the previous wall insulation measure was replaced.

Achievable workshop participants provided 2030 participation rate estimates of 17% for the upper Achievable Potential scenario and 3% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve both scenarios would be B.

The depth of the insulation measures considered in the study was greatly increased because of the discussions in the workshop. Several participants had direct experience with deep retrofits that had good results.

Barriers that tend to lower adoption included a lack of contractors experienced in doing this kind of retrofit; most are accustomed to installing far less insulation and will therefore charge more than necessary for this unfamiliar type of job.

Strategies to encourage adoption of deep retrofit wall insulation might include offering financing, demonstrations, education of homeowners and contractors, utility pre-qualification or certification of contractors, and partnerships with other entities such as the Climate Change Secretariat, the Yukon Energy Solutions Centre, and the Cold Climate Research Centre. The wall insulation measure should likely be considered as part of a package that would also improve the rest of the house envelope.

The initial discussion focused on existing single detached homes on the hydro grid. Participants believed participation would be somewhat lower in attached homes. The measure does not apply off the hydro grid because electric heating is negligible there. Participants also discussed some of the other building envelope measures. Most of them were thought to have similar adoption rates. Basement insulation might be adopted somewhat faster than wall insulation. Attic insulation would also likely be adopted somewhat faster.

10.4.6 DHW Recirculation

Achievable workshop participants provided 2030 participation rate estimates of 30% for the upper Achievable Potential scenario and 5% for the lower Achievable Potential scenario. Participants thought the most likely adoption curve both scenarios would be B.

Barriers that tend to lower adoption included a lack of familiarity with the technology and a lack of trades people who can install it. It may also be difficult to obtain the products in Yukon. Many recently-built homes have manifold plumbing systems, which would require more pumps than a system with several fixtures in series along the same run of pipe. The systems require an electrical supply to the location of the pump (e.g., under a sink in the bathroom), along with the installation and configuration of the controls.

Strategies to encourage adoption of DHW recirculation include marketing it as a luxury or convenience item that can differentiate high-end homes from the rest of the market, marketing the system with other DHW measures, or selling it based on its water conservation features for people on water delivery or well systems.

The initial discussion focused on existing single detached homes on the hydro grid. Participants believed participation would be somewhat lower in apartments, as some of them have central DHW systems. Participants thought adoption would be somewhat faster in the homes on the large diesel grid and higher still in homes on the small diesel and Old Crow systems, because of the larger number of homes that have their water supplied by truck.

Participants did not have time to discuss the other DHW measures. In extrapolating to the other measures, experience from other jurisdictions suggests that adoption of measures such as low-flow showerheads, pipe insulation and tank insulation would be faster than DHW recirculation. DHW piping optimization would likely be adopted at approximately the same rate as recirculation, and wastewater heat recovery would likely be adopted more slowly.

10.4.7 High-Performance New Homes

Achievable workshop participants provided 2030 participation rate estimates of 95% for both Achievable Potential scenarios. Participants thought the most likely adoption curve of both scenarios would be D, with the curve leveling off in 2017 in the upper Achievable Potential scenario but not until 2022 in the lower Achievable Potential scenario.

Barriers that tend to lower adoption include resistance in the contracting community and a perception of higher cost. Demand for housing is very high and there is urgency in building housing to meet this demand.

New construction in Yukon between now and 2030 is expected to include a great deal of electric heat. If efficiencies are not captured in these new homes when they are built, the opportunities will probably be lost for decades.

Strategies to encourage adoption of high-performance new homes may include working with other stakeholders, such as the Yukon Housing Corporation and municipalities. Whitehorse has very successfully implemented a building code that requires EGH-80 for new homes. A move to EGH-85 was seen as a strong option for implementing this measure. Other approaches might include contests among builders, green mortgages, labelling and branding, testimonials and free rating services. The high-performance homes could be marketed based on their comfort, simple mechanical systems, indoor air quality, and durability as well as their electric energy savings.

The initial discussion focused on existing single detached homes on the hydro grid. Participants did not note any likely differences in the adoption rate for attached homes or government homes. The measure does not apply in the diesel grid communities because of the lack of electric heat in those communities.

Participants did not discuss other new construction measures. The participation rates for LEED certified apartment buildings were drawn from the commercial sector discussions. Net zero homes likely rely on the cost-effectiveness of photovoltaic systems, which were a topic of discussion in the CSRAE workshop.

10.4.8 Cold Climate Heat Pumps

Achievable workshop participants provided 2030 participation rate estimates of 75% for the upper Achievable Potential scenario and 25% for the lower Achievable Potential Scenario. Participants thought the most likely adoption curve both scenarios would be B.

Barriers that tend to lower adoption include first cost, lack of installers, low awareness and customer understanding, and a perception that heat pumps do not work in northern climates.

Although there are some heat pumps operating well in Yukon, testing of different models in the Yukon climate will be important to demonstrate which ones are viable.

Other strategies to encourage adoption of cold climate heat pumps could include incentives, education programs aimed at both consumers and installers, third-party validation or certification of installers, development of Yukon-specific information on the real cost of heating in Yukon, and collaboration with other entities such as the Yukon Housing Corporation or the federal government.

The initial discussion focused on existing single detached homes on the hydro grid. Participants expected adoption to be higher in new homes. The measure does not apply in the diesel grid communities because of the lack of electric heat in those communities.

Participants discussed some of the other electric heating equipment measures. Adoption of ductless mini-splits was expected to be slower because it is more expensive to heat a whole house with those systems. Adoption of zone heating was also expected to be slower because it is such unfamiliar technology. Adoption of programmable thermostats and high-efficiency furnace motors was expected to be faster than that of heat pumps. Adoption of ground-source heat pumps and solar preheat of makeup air was expected to be much slower, because of their high capital cost and limited applicability.

Participants raised other approaches to using heat pumps in Yukon, most of which are highly promising but beyond the direct scope of this project. For example, cold climate heat pumps could be incorporated into new or existing homes with oil furnaces. The heat pump could operate through most of the heating season and the oil furnace would provide backup during the coldest days, instead of electric resistance heating. From the standpoint of operating costs, this would be one of the least expensive ways to heat a home in Yukon.

Another option would be to consider adding a standard heat pump to an oil-heated home. The standard heat pump would not operate for as many hours of the winter as the cold climate model, and the oil furnace would supply more of the heat, but the capital cost would be considerably lower. Using a standard heat pump in conjunction with an oil furnace would mean that the home would be heated by oil during the coldest periods when the utility is typically generating peak power using diesel generators.

Cold climate heat pumps, if local testing turns out well, have great potential for reducing consumption in homes with electric resistance heat. In homes with oil heat, standard heat pumps with no resistance backup might be a better choice. They are less expensive and would offer considerable savings without adding peak load to the grid. This would greatly increase the market for heat pumps, possibly offering savings due to sales volumes.

10.4.9 Aggregate Results

Exhibit 49 summarizes the participant rate and “ramp up” curve assumptions discussed above.

Exhibit 49 Summary of Achievable Potential Participation Rates and Curves

Technology	Lower Achievable Potential		Upper Achievable Potential	
	2030 Participation Factor	Adoption Curve	2030 Participation Factor	Adoption Curve
R1: ENERGY STAR® Clothes	65%	Curve B	80%	Curve C
R2: Block Heater Timers	50%	Curve B (shallow)	70%	Curve B
R3: Power Bars (PCs)	20%	Shallow Curve B	40%	Shallow Curve B
R4: LED Lamps	70%	Curve B	85%	Curve B
R5: Wall Insulation	3%	Curve B	17%	Curve B
R6: DHW Recirculation	5%	Curve B	30%	Curve B
R7: High-Performance New Homes	95%	Curve D (in 2022)	95%	D (in 2017) Whitehorse only
R8: Cold Climate Heat Pumps	25%	Curve B	75%	Curve B

As noted earlier, it was not possible to fully address all opportunities in the one-day workshop. Consequently, the workshop focused on opportunities selected based on the criteria described in Step 1. Estimated participation rates for the remaining opportunities were extrapolated from the workshop results shown above and an aggregate set of results was prepared that included all of the eligible technologies.

The results shown in the attached appendices and in the following summary section incorporate the results of all these inputs.

10.5 Summary of Potential Electric Energy Savings

This section presents a summary of the electric energy savings for the upper and lower achievable potential scenarios. The summary is organized and presented in the following sub sections:

- Overview and selected highlights
- Electric energy savings – Upper Achievable scenario
- Electric energy savings – Lower Achievable scenario.

10.5.1 Overview and Selected Highlights

Exhibit 50 presents an overview of the results for the total Yukon service territory by milestone year, for three scenarios: Economic Potential, upper Achievable Potential and lower Achievable Potential.

Exhibit 50 Electricity Savings by Milestone Year for Three Scenarios (MWh/yr.)

Year	Economic Potential Scenario		Upper Achievable Potential Scenario		Lower Achievable Potential Scenario	
	Potential Savings (MWh/yr.)	% Savings Relative to Ref Case	Potential Savings (MWh/yr.)	% Savings Relative to Ref Case	Potential Savings (MWh/yr.)	% Savings Relative to Ref Case
2015	37,239	24%	5,114	3%	2,711	2%
2020	42,577	25%	13,554	8%	7,792	5%
2025	49,419	25%	23,599	12%	13,539	7%
2030	57,248	25%	37,098	16%	22,240	10%

Selected Highlights – Potential Electric Energy Savings

Selected highlights of the potential electric energy savings for the upper and lower achievable potential scenarios shown in Exhibit 50 are summarized below. Further detail is provided in the following sub sections and in the accompanying appendices.

Savings by Milestone Year

Savings in both Achievable scenarios are achieved somewhat more steadily throughout the period than in the Economic Potential scenario. In the upper Achievable Potential scenario, 14% of the 2030 savings would be achieved by 2015, rising to 37% in 2020 and 64% by 2020. In the lower Achievable Potential scenario, 12% of the 2030 savings would be achieved by 2015, rising to 35% in 2020 and 61% by 2025. Although there are some measures in both scenarios that can be implemented early in the study period, the majority are expected to follow an adoption curve that starts slowly and builds up towards 2030.

Savings by Dwelling Type

Single-family dwellings account for approximately 68% of the upper Achievable Potential savings and 70% of the lower Achievable Potential savings; this reflects their larger market share and their generally higher level of energy intensity per dwelling. In fact, the subset of single-family dwellings built since1980 account for 50% of the 2030 upper Achievable Potential and 57% of the 2030 lower Achievable Potential. This reflects the large amount of new construction expected during the study period and the substantial amount of electric heat these new dwellings are expected to include.

Savings by Supply Type and Government versus Non-government Accounts

The accounts connected to the hydro grid are expected to account for 98% of potential savings in 2030. Non-government accounts provide 97% of these savings and government accounts provide the other 1%. The large diesel, small diesel and Old Crow customers account for the remaining 2%. The diesel grid systems are a smaller portion of the potential savings than they are of the reference case consumption, because many of the most promising measures reduce electric space heating consumption and there is little or no electric space heating in those communities.

Savings by End Use

Space heating savings account for 56% of the upper Achievable Potential savings in 2030 and 55% of the lower Achievable Potential savings. The most significant measures that save space heating include high-performance new homes, heat pumps (both central units and ductless mini-splits), zone heating systems and LEED certified apartment buildings.

Space heating accounts for a very large percentage of the potential, but the space heating savings potential is also a very large percentage of the reference case space heating consumption. Between 22% and 37% of space heating could potentially be saved, respectively, in the lower and upper Achievable Potential scenarios. The potential in electrically-heated dwellings, as a percentage of their reference case consumption, is three to four times as large as it is in dwellings without electric heat.

Domestic hot water savings account for 13% of 2030 upper Achievable Potential savings and 14% of lower Achievable Potential savings. The measure that saves the most domestic hot water is the efficient clothes washer.

In the upper Achievable Potential scenario, clothes dryers account for 8% of 2030 savings and computers account for 6%. In the lower Achievable Potential scenario, clothes dryers account for 10% of 2030 savings and computers account for 5%. The reduction in clothes dryer electricity comes from the faster spin speeds in the high-efficiency clothes washers, which reduce drying time. The savings in computers and their peripherals are expected to come primarily from the use of smart power bars that reduce standby losses.

The remaining end uses are all under 5% in both scenarios. There are savings available in 13 other end uses. Together they account for 17% of upper Achievable Potential savings in 2030 and 16% of lower Achievable Potential savings in 2030.

Savings by Measure

The most significant savings in the Achievable Potential come from the following measures:

- High-performance new homes, which account for 18% of the upper Achievable Potential savings in 2030 and 31% of the lower Achievable Potential savings in 2030
- Cold temperature heat pumps, which account for 14% of the upper Achievable Potential savings in 2030 and 10% of the lower Achievable Potential savings in 2030
- ENERGY STAR® clothes washers, which account for 11% of the upper Achievable Potential savings in 2030 and 14% of the lower Achievable Potential savings in 2030
- LEED certified apartment buildings, which account for 10% of the upper Achievable Potential savings in 2030 and 8% of the lower Achievable Potential savings in 2030
- Zone heating systems, which account for 9% of the upper Achievable Potential savings in 2030 and 6% of the lower Achievable Potential savings in 2030
- Ductless mini-split systems, which account for 4% of the upper Achievable Potential savings in 2030 and 3% of the lower Achievable Potential savings in 2030
- Power bars for PCs and TVs, which account for 4% of the upper Achievable Potential savings in 2030 and 3% of the lower Achievable Potential savings in 2030.

There are numerous other smaller measures that contribute to the overall Achievable Potential results.

10.5.2 Electric Energy Savings – Upper Achievable Scenario

The following exhibits present the potential electricity savings[27] under the upper Achievable Potential scenario. The results shown are relative to the Reference Case. The results are broken down as follows:

- Exhibit 51 presents the results by supply system, by government versus non-government accounts, and by milestone year
- Exhibit 52 presents the results for the total Yukon service territory by dwelling type and milestone year

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[27] Note: A value of "0" in the following exhibits means a relatively small number, not an absolute value of zero.

- Exhibit 53 presents the results for the total Yukon service territory by end use and milestone year
- Exhibit 54 presents the results for the total Yukon service territory by technology and milestone year.

Exhibit 51 Upper Achievable Electricity Savings by Supply System and Government vs Non-government Customers (MWh/yr.)

Supply System/Government vs Non-government	2015	2020	2025	2030	2030 Savings Relative to Ref Case (%)	Fraction of Total 2030 Savings (%)
Hydro Grid - Nongovt	4,836	12,958	22,732	35,893	16%	97%
Hydro Grid - Govt	71	185	323	534	15%	1%
Large Diesel - Nongovt	158	302	386	464	7%	1%
Large Diesel - Govt	9	17	21	25	7%	0%
Small Diesel - Nongovt	17	39	57	71	7%	0%
Small Diesel - Govt	4	8	11	14	7%	0%
Old Crow - Nongovt	17	38	58	83	7%	0%
Old Crow - Govt	3	7	11	15	8%	0%
Grand Total	5,114	13,554	23,599	37,098	16%	100%

Exhibit 52 Upper Achievable Electricity Savings by Dwelling Type and Milestone Year (MWh/yr.)

Dwelling Type	2015	2020	2025	2030	2030 Savings Relative to Ref Case (%)	Fraction of Total 2030 Savings (%)
1980 & newer non-electrically heated single detached homes	455	1,177	1,908	3,062	5%	14%
Pre-1980 non-electrically heated single detached homes	360	834	1,221	1,799	5%	8%
1980 & newer electrically heated single detached homes	1,185	3,622	6,212	9,481	24%	43%
Pre-1980 electrically heated single detached homes	126	385	756	1,233	11%	6%
1980 & newer non-electrically heated attached/row housing	48	123	198	318	5%	1%
Pre-1980 non-electrically heated attached/row housing	37	85	124	181	5%	1%
1980 & newer electrically heated attached/row housing	153	504	916	1,488	24%	7%
Pre-1980 electrically heated attached/row housing	11	33	64	104	10%	0%
Non-electrically heated apartment units	67	169	240	366	3%	2%
Non-electrically heated apartment common areas	52	122	125	166	5%	1%
Electrically heated apartment units	34	230	854	2,340	12%	11%
Electrically heated apartment common areas	8	51	167	453	10%	2%
Non-electrically heated mobile/other	85	199	292	436	5%	2%
Electrically heated mobile/other	30	113	274	542	11%	2%
Small diesel grid housing	18	42	64	91	4%	0%
Seasonal housing	25	51	31	21	0%	0%
Residential garages	9	19	18	21	2%	0%
Sentinel Lighting	8	32	75	137	20%	1%
Grand Total	2,711	7,792	13,539	22,240	10%	100%

Note: Any difference in totals is due to rounding.

Exhibit 53 Upper Achievable Electricity Savings by End Use and Milestone Year (MWh/yr.)

End Use	2015	2020	2025	2030	2030 Savings Relative to Ref Case (%)	Fraction of Total 2030 Savings (%)
Space heating	1,126	4,973	11,437	20,632	37%	56%
Ventilation & circulation	302	518	620	566	7%	2%
Domestic hot water (DHW)	977	2,153	3,475	4,972	16%	13%
Indoor lighting	662	1,413	882	600	5%	2%
Outdoor lighting	39	83	96	150	5%	0%
Holiday lighting	28	39	32	9	36%	0%
Refrigerator	120	362	677	837	8%	2%
Freezer	30	92	189	317	5%	1%
Dishwasher	13	37	51	64	7%	0%
Clothes washer	58	94	118	128	23%	0%
Clothes dryer	974	1,865	2,617	3,029	23%	8%
Spa heaters and pumps	133	210	316	476	7%	1%
Computer and peripherals	331	721	1,357	2,342	10%	6%
Television	194	650	934	1,236	17%	3%
Set-top boxes	-	-	35	111	3%	0%
Home entertainment electronics	10	37	172	647	5%	2%
Block heaters & car warmers	117	307	589	983	23%	3%
Grand Total	5,114	13,554	23,599	37,098	16%	100%

Note: DHW savings include savings from reduced DHW consumption by efficient clothes washers and dishwashers. Any difference in totals is due to rounding.

Exhibit 54 Upper Achievable Electricity Savings by Technology and Milestone Year (MWh/yr.)

End Use	Measure	2015	2020	2025	2030	Adoption Curve	Weighted Average CCE (¢/kWh)
Space Heating	**High-Perf. New Homes**	674	2,830	5,266	7,187	D-2017	9.6
Clothes Dryer/DHW/Washer	**ESTAR Clothes Washers**	1,475	2,757	3,823	4,381	C	15.5
Space Heating	**Cold Temp Heat Pumps**	286	1,238	2,929	5,465	B	18.2
Space Heating	**Zone Heating**	136	644	1,689	3,481	B	15.0
Space Heating	**LEED Apartments**	30	308	1,313	3,847	B	10.2
Space Heating	**Ductless Mini-Splits**	82	357	850	1,595	B	13.3
Computer and peripherals	**Power Bars (PCs)**	131	349	650	1,007	A/B	8.4
Television	**ESTAR TVs**	143	518	660	725	C	24.1
Indoor lighting	**CFLs - Indoor**	515	1,054	442	-	F	1.1
Refrigerator	**ESTAR Refrigerators**	120	362	677	837	C	6.2
Ventilation & circulation	**Furnace Motors**	296	489	556	449	A	21.0
Computer/Television/Electr.	**Future Elec Improvement**	-	-	350	1,392	B	11.5
Computer and peripherals	**ESTAR Printers and Fax**	200	372	518	647	C	15.9
Block heaters & car warmers	**Block Heater Timers**	96	252	482	806	A/B	4.7
Domestic hot water (DHW)	**Showerheads**	215	368	481	560	A	0.8
Space Heating	**Prog. Thermostats (Central)**	141	260	355	428	A	0.9
Television/Set top boxes	**Power Bars (TVs)**	61	169	321	563	A/B	14.1
Space Heating	**Outdoor Temp Reset**	23	108	284	591	B	8.9
Domestic hot water (DHW)	**DHW Recirculation**	23	106	271	540	B	14.2
DWH/Dishwasher	**ESTAR Dishwashers**	73	204	276	330	C	12.6
Domestic hot water (DHW)	**DHW Tank Insulation**	78	157	245	338	A	7.4
Indoor lighting	**LED Lamps**	26	99	241	451	B	11.4
Domestic hot water (DHW)	**DHW Piping Optimization**	20	92	233	458	B	21.1
Domestic hot water (DHW)	**DHW Pipe Insulation**	61	123	192	266	A	0.2
Freezer	**ESTAR Freezers**	30	92	189	317	C	13.2
Space Heating	**Wall Insulation**	22	85	183	311	B	21.0
Space Heating	**Prog. Thermostats**	58	114	166	215	A	4.2
Spa heaters and pumps	**Heat Pump Spa Heaters**	58	87	123	173	A/B	5.7
Spa heaters and pumps	**Hot Tub Pump Timers**	43	71	111	175	A/B	1.0

End Use	Measure	2015	2020	2025	2030	Adoption Curve	Weighted Average CCE (¢/kWh)
Space Heating	Attic Insulation	13	49	104	174	B	8.4
Space Heating	Ground Heat Pumps - Closed	7	31	85	163	B	33.4
Domestic hot water (DHW)	Wastewater Heat Recovery	5	26	74	159	B	17.6
Indoor lighting	PAR CFLs	66	133	55	-	F	8.9
Outdoor lighting	Pulse start metal halide sentinel lights	8	32	75	137	A	3.8
Space Heating	Solar Pre-heat Makeup Air	5	26	69	137	B	28.6
Space Heating	Sealing & Insul. - Old Homes	8	33	72	125	B	11.0
Block heaters & car warmers	Car Warmer Timers	12	31	60	100	A/B	2.0
Spa heaters and pumps	Spa Pumps	21	35	54	85	A/B	23.1
Indoor lighting	T8 Fixtures	4	23	63	84	B	14.8
Block heaters & car warmers	Battery Blanket Timers	9	24	46	77	A/B	22.7
Space Heating	Air Sealing	5	21	47	81	B	11.9
Indoor lighting	Dimmable CFLs	37	75	32	-	F	6.7
Indoor lighting	Spot or Task Lighting	9	18	28	35	A/B	8.3
Outdoor lighting	CFLs - Outdoor	29	45	12	-	F	1.7
Space Heating	Basement Insulation	6	17	25	21	B	9.2
Indoor lighting	Motion Detectors - Indoor	5	11	20	30	A/B	5.1
Spa heaters and pumps	Solar Spa Pre-heat	7	12	18	29	A/B	5.2
Holiday lighting	LED Holiday - Outdoor	17	23	19	5	A	7.9
Space Heating	HRVs	1	7	20	30	B	24.8
Space Heating	Triple-glazed Windows	1	6	16	34	B	21.5
Holiday lighting	LED Holiday - Indoor	12	16	13	4	A	29.3
Space Heating	Slab Insulation	2	6	12	19	B	24.2
Spa heaters and pumps	Hot Tub Covers	4	6	9	15	A/B	2.0
Outdoor lighting	Motion Detectors - Outdoor	3	6	9	13	A/B	4.8
Space Heating	Optimizing Glazing for Passive	0	2	4	9	B	26.0
Space Heating	Quadruple-glazed Windows	0	1	2	3	B	26.0
Space Heating	Crawl Space Insulation	0	0	1	1	B	20.7
Grand Total		5,410	14,378	24,923	39,105		12.5

Note: The grand totals are slightly higher than in the previous two exhibits because the interactive effects of the internal load reductions on space heating are omitted from this exhibit.

Curves A, B, and C in this exhibit are as presented in Exhibit 48. Curve D-2017 is the shape of curve D from Exhibit 48, with the curve levelling off after 2017. Curve A/B was called "shallow B" by the participants and is halfway between curves A and B. Curve F is shaped like a bell curve and is used because compact fluorescents are expected to be superseded in the marketplace by LEDs after approximately 2020.

10.5.3 Electric Energy Savings – Lower Achievable Scenario

The following exhibits present the potential electricity savings[28] under the lower Achievable Potential scenario. The results shown are relative to the Reference Case. The results are broken down as follows:

- Exhibit 55 presents the results by supply system, by government versus non-government accounts, and by milestone year
- Exhibit 56 presents the results for the total Yukon by dwelling type and milestone year
- Exhibit 57presents the results for the total Yukon by end use and milestone year
- Exhibit 58 presents the results for the total Yukon by technology and milestone year.

Exhibit 55 Lower Achievable Electricity Savings by Supply System and Government vs. government Customers (MWh/yr.)

Supply System/Government vs Non-government	2015	2020	2025	2030	2030 Savings Relative to Ref Case (%)	Fraction of Total 2030 Savings (%)
Hydro Grid - Nongovt	2,602	7,514	13,094	21,537	10%	97%
Hydro Grid - Govt	35	99	173	301	9%	1%
Large Diesel - Nongovt	53	126	193	286	4%	1%
Large Diesel - Govt	3	7	10	15	4%	0%
Small Diesel - Nongovt	8	20	30	40	4%	0%
Small Diesel - Govt	2	4	5	7	3%	0%
Old Crow - Nongovt	8	19	29	45	4%	0%
Old Crow - Govt	1	3	5	8	4%	0%
Grand Total	2,711	7,792	13,539	22,240	10%	100%

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[28] A value of "0" in the following exhibits means a relatively small number, not an absolute value of zero.

Exhibit 56 Lower Achievable Electricity Savings by Dwelling Type and Milestone Year (MWh/yr.)

Dwelling Type	2015	2020	2025	2030	2030 Savings Relative to Ref Case (%)	Fraction of Total 2030 Savings (%)
1980 & newer non-electrically heated single detached homes	455	1,177	1,908	3,062	5%	14%
Pre 1980 non-electrically heated single detached homes	360	834	1,221	1,799	5%	8%
1980 & newer electrically heated single detached homes	1,185	3,622	6,212	9,481	24%	43%
Pre-1980 electrically heated single detached homes	126	385	756	1,233	11%	6%
1980 & newer non-electrically heated attached/row housing	48	123	198	318	5%	1%
Pre 1980 non-electrically heated attached/row housing	37	85	124	181	5%	1%
1980 & newer electrically heated attached/row housing	153	504	916	1,488	24%	7%
Pre-1980 electrically heated attached/row housing	11	33	64	104	10%	0%
Non-electrically heated apartment units	67	169	240	366	3%	2%
Non-electrically heated apartment common areas	52	122	125	166	5%	1%
Electrically heated apartment units	34	230	854	2,340	12%	11%
Electrically heated apartment common areas	8	51	167	453	10%	2%
Non-electrically heated mobile/other	85	199	292	436	5%	2%
Electrically heated mobile/other	30	113	274	542	11%	2%
Small diesel grid housing	18	42	64	91	4%	0%
Seasonal housing	25	51	31	21	0%	0%
Residential garages	9	19	18	21	2%	0%
Sentinel Lighting	8	32	75	137	20%	1%
Grand Total	2,711	7,792	13,539	22,239	10%	100%

Note: Any difference in totals is due to rounding.

Exhibit 57 Lower Achievable Electricity Savings by End Use and Milestone Year (MWh/yr.)

End Use	2015	2020	2025	2030	2030 Savings Relative to Ref Case (%)	Fraction of Total 2030 Savings (%)
Space heating	1,195	3,851	7,294	12,272	22%	55%
Ventilation & circulation	121	217	268	266	3%	1%
Domestic hot water (DHW)	461	1,153	1,993	3,064	10%	14%
Indoor lighting	526	1,127	700	473	4%	2%
Outdoor lighting	32	71	89	144	4%	1%
Holiday lighting	25	35	29	8	32%	0%
Refrigerator	18	99	271	399	4%	2%
Freezer	4	26	80	184	3%	1%
Dishwasher	1	8	16	26	3%	0%
Clothes washer	7	25	55	97	18%	0%
Clothes dryer	113	498	1,229	2,285	18%	10%
Spa heaters and pumps	37	97	188	332	5%	1%
Computer and peripherals	89	240	552	1,087	5%	5%
Television	42	182	315	527	7%	2%
Set-top boxes	-	-	18	55	1%	0%
Home entertainment electronics	5	19	86	326	3%	1%
Block heaters & car warmers	33	145	356	693	16%	3%
Grand Total	2,711	7,792	13,539	22,240	10%	100%

Note: DHW savings include savings from reduced DHW consumption by efficient clothes washers and dishwashers. Any difference in totals is due to rounding.

Exhibit 58 Lower Achievable Electricity Savings by Technology and Milestone Year (MWh/yr.)

End Use	Measure	2015	2020	2025	2030	Adoption Curve	Weighted Average CCE (¢/kWh)
Space Heating	High-Perf. New Homes	1,158	3,406	5,286	7,211	D-2022	9.6
Clothes Dryer/DHW/Washer	ESTAR Clothes Washers	171	735	1,790	3,284	B	15.8
Space Heating	Cold Temp Heat Pumps	98	444	1,147	2,289	B	18.3
Space Heating	LEED Apartments	15	154	659	1,931	B	10.2
Space Heating	Zone Heating	48	240	686	1,506	B	15.6
Indoor lighting	CFLs - Indoor	412	843	354	-	F	1.1
Domestic hot water (DHW)	Showerheads	167	285	372	432	A	0.8
Space Heating	Ductless Mini-Splits	28	131	346	699	B	13.4
Computer and peripherals	Power Bars (PCs)	66	174	325	504	A/B	8.4
Block heaters & car warmers	Block Heater Timers	27	119	292	568	B	4.7
Computer/Television/Electr.	Future Elec Improvement	-	-	182	731	B	11.5
Refrigerator	ESTAR Refrigerators	18	99	271	399	B	6.3
Ventilation and circulation	Furnace Motors	112	186	214	178	A	20.8
Indoor lighting	LED Lamps	21	83	200	372	B	11.4
Domestic hot water (DHW)	DHW Tank Insulation	60	122	189	261	A	7.4
Television	ESTAR TVs	17	116	175	259	B	24.1
Television/Set top boxes	Power Bars (TVs)	30	85	161	281	A/B	14.1
Domestic hot water (DHW)	DHW Pipe Insulation	47	96	148	205	A	0.2
Space Heating	Prog. Thermostats (Central)	53	99	137	167	A	0.9
Computer and peripherals	ESTAR Printers and Fax	23	66	128	220	B	15.9
Space Heating	Outdoor Temp Reset	8	40	115	253	B	9.3
Freezer	ESTAR Freezers	4	26	80	184	B	13.3
DHW/Dishwasher	ESTAR Dishwashers	9	45	81	128	B	13.3
Outdoor lighting	Pulse start metal halide sentinel lights	8	32	75	137	A	3.8
Spa heaters and pumps	Heat Pump Spa Heaters	15	38	70	115	B	5.7
Spa heaters and pumps	Hot Tub Pump Timers	12	34	68	125	B	1.0
Indoor lighting	PAR CFLs	53	106	44	-	F	8.9
Space Heating	Prog. Thermostats	19	38	57	75	A	4.2
Domestic hot water (DHW)	DHW Recirculation	4	20	51	101	B	14.4

End Use	Measure	2015	2020	2025	2030	Adoption Curve	Weighted Average CCE (¢/kWh)
Domestic hot water (DHW)	DHW Piping Optimization	4	17	44	87	B	21.5
Space Heating	Ground Heat Pumps - Closed	2	12	39	93	B	33.6
Indoor lighting	T8 Fixtures	4	19	52	69	B	14.8
Block heaters & car warmers	Car Warmer Timers	3	15	36	71	B	2.1
Spa heaters and pumps	Spa Pumps	6	17	33	61	B	23.3
Indoor lighting	Dimmable CFLs	30	60	25	-	F	6.7
Space Heating	Solar Pre-heat Makeup Air	2	11	31	70	B	28.9
Space Heating	Wall Insulation	4	15	32	55	B	21.0
Block heaters & car warmers	Battery Blanket Timers	3	11	28	54	B	22.9
Indoor lighting	CFLs - Outdoor	23	36	10	-	F	1.7
Holiday lighting	LED Holiday - Outdoor	17	23	19	5	A	7.9
Space Heating	Attic Insulation	2	9	18	31	B	8.4
Domestic hot water (DHW)	Wastewater Heat Recovery	1	5	14	31	B	18.3
Indoor lighting	Spot or Task Lighting	5	9	14	18	A/B	8.3
Space Heating	Sealing & Insul. - Old Homes	1	6	13	22	B	11.0
Spa heaters and pumps	Solar Spa Pre-heat	2	6	11	21	B	5.2
Indoor lighting	Motion Detectors - Indoor	3	6	10	15	A/B	5.1
Holiday lighting	LED Holiday - Indoor	9	12	10	3	A	29.3
Space Heating	Air Sealing	1	4	8	14	B	11.9
Space Heating	HRVs	0	2	7	11	B	24.8
Spa heaters and pumps	Hot Tub Covers	1	3	6	11	B	2.0
Outdoor lighting	Motion Detectors - Outdoor	1	3	5	6	A/B	4.8
Space Heating	Basement Insulation	1	3	4	4	B	9.2
Space Heating	Triple-glazed Windows	0	1	3	6	B	21.5
Space Heating	Slab Insulation	0	1	2	3	B	24.2
Space Heating	Optimizing Glazing for Passive	0	0	1	2	B	26.0
Space Heating	Quadruple-glazed Windows	0	0	0	1	B	26.0
Space Heating	Crawl Space Insulation	0	0	0	0	B	20.7
Grand Total		4,843	10,186	16,205	25,407		11.3

Note: The grand totals are slightly higher than in the previous two exhibits because the interactive effects of the internal load reductions on space heating are omitted from this exhibit.

Curves A, B, and C in this exhibit are as presented in Exhibit 48. Curve D-2022 is the shape of curve D from Exhibit 48, with the curve levelling off after 2022. Curve A/B was called “shallow B” by the participants and is halfway between curves A and B. Curve F is shaped like a bell curve and is used because compact fluorescents are expected to be superseded in the marketplace by LEDs after approximately 2020.

10.6 Summary of Electric Peak Load Reductions

This section presents a summary of the electric peak load reductions that would result from the electric energy savings presented above for the upper and lower achievable scenarios. The summary is organized and presented in the following sub sections:

- Overview and selected highlights
- Electric peak load reductions – Upper Achievable scenario
- Electric peak load reductions – Lower Achievable scenario

10.6.1 Overview and Selected Highlights

Exhibit 59 presents an overview of the results for the total Yukon service territory by milestone year for each of the achievable potential scenarios. As illustrated, by 2030 peak load reductions resulting from implementation of the energy-efficiency measures are estimated to range from 10.5 MW to 6.4 MW (19% to 12% of Reference Case demand) for the upper and lower Achievable Potential scenarios, respectively. Additional highlights are provided below.

Exhibit 59 Electric Peak Load Reductions for Upper and Lower Achievable Potential Scenarios (MW)

Scenario	Milestone Year	Period 1 Annual Peak Hour		Period 2 Evening Peak Period		Period 3 Morning Peak Period	
Upper Achievable	2015	1.3	3%	1.3	4%	0.8	3%
	2020	3.6	9%	3.6	9%	2.3	8%
	2025	6.5	14%	6.4	15%	4.3	14%
	2030	10.5	19%	10.4	20%	7.0	19%
Lower Achievable	2015	0.8	2%	0.8	2%	0.5	2%
	2020	2.3	6%	2.3	6%	1.5	5%
	2025	3.9	8%	3.9	9%	2.6	8%
	2030	6.4	12%	6.4	12%	4.2	11%

Selected Highlights – Potential Electric Peak Load Reductions

Most measures contribute to the peak demand reductions approximately in proportion to their electric energy savings. There are some notable exceptions. Block heaters are used at times that coincide closely with the utility peak, so their demand reduction would be disproportionate to their share of the electricity consumption savings. The potential reduction from block heater timers is even more significant than this would suggest, however, because the timer measure changes the load shape by moving the consumption almost entirely off the utility peak. Block heater timers offer the second largest potential for reducing peak demand in the Residential sector.

In contrast, the central heat pump and ductless mini-split systems, which both offer considerable electric energy savings potential, provide no reduction in peak electrical demand. This is because the utility peak occurs during the coldest period of the heating season, when these systems cease to operate as heat pumps and make use of their electric resistance backup heating elements.

Further discussion of the electric peak load reductions under the upper Achievable Potential forecast and the lower Achievable Potential forecast are presented in the following sub sections.

10.6.2 Electric Peak Load Reductions Under the Upper Achievable Potential Scenario

Exhibit 60 presents a summary of the peak load reductions that would occur as a result of the electric energy savings contained in the upper Achievable Potential forecast. The reductions are shown by milestone year and peak period. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case presented previously in Section 4. Exhibit 61 shows the same information graphically for the Annual Peak Hour.

As discussed in Section 8.7, Exhibit 60 and Exhibit 61 approximate the potential demand impacts associated with the energy-efficiency measures because they are based on the assumption that the measures do not change the load shape of the end uses they affect. Exhibit 62, which shows the demand reductions associated with each electric energy savings measure, uses a more accurate estimate of block heater load reduction that accounts for the fact that use of the timer both reduces electric energy use and changes the shape of the block heater load.

Exhibit 60 Electric Peak Load Reductions from Upper Achievable Energy Savings Measures, by Milestone Year, Peak Period and Dwelling Type (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	2015	1.0	1.0	0.6
	2020	2.8	2.7	1.8
	2025	4.8	4.7	3.2
	2030	7.1	7.0	4.9
Apartment/Condo Buildings	2015	0.1	0.1	0.0
	2020	0.3	0.3	0.2
	2025	0.8	0.8	0.5
	2030	1.9	1.9	1.2
Attached/Row Houses	2015	0.1	0.1	0.1
	2020	0.3	0.3	0.2
	2025	0.5	0.5	0.3
	2030	0.9	0.9	0.6
Mobile Homes	2015	0.1	0.1	0.0
	2020	0.2	0.2	0.1
	2025	0.3	0.3	0.2
	2030	0.5	0.5	0.4
Small Grid Housing	2015	0.01	0.01	0.01
	2020	0.02	0.02	0.01
	2025	0.03	0.03	0.02
	2030	0.03	0.03	0.02
Seasonal and Garages	2015	0.01	0.01	0.01
	2020	0.03	0.03	0.01
	2025	0.02	0.03	0.01
	2030	0.02	0.03	0.01
Sentinel Lighting	2015	0.00	0.00	0.00
	2020	0.01	0.01	0.01
	2025	0.02	0.02	0.02
	2030	0.03	0.03	0.03
Grand Total	2015	1.3	1.3	0.8
	2020	3.6	3.6	2.3
	2025	6.5	6.4	4.3
	2030	10.5	10.4	7.0

Exhibit 61 Electric Peak Load Reductions from Upper Achievable Energy Savings Measures, by Milestone Year and Dwelling Type, Annual Peak Hour (MW)

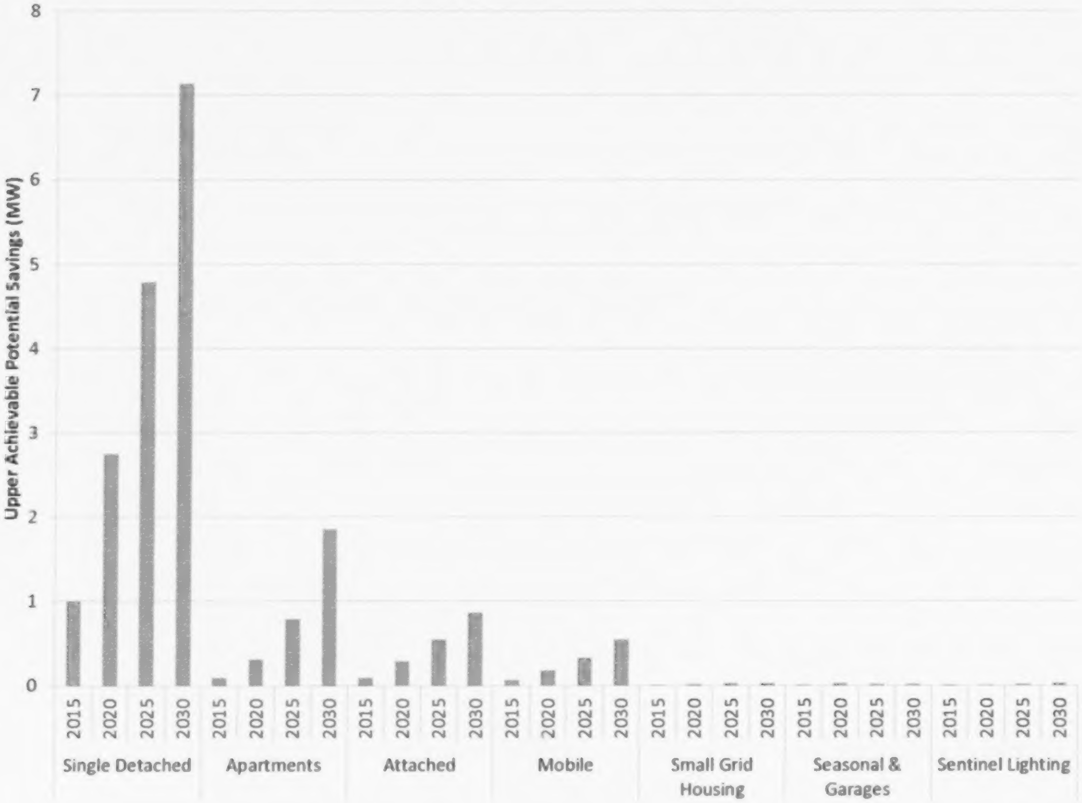

Exhibit 62 Electric Peak Load Reductions from Upper Achievable Energy Savings Measures, 2030 (MW)

Measure	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
High-Perf. New Homes	2.37	2.33	1.71
Block Heater Timers	1.75	2.19	0.00
Zone Heating	1.24	1.22	0.80
LEED Apartments	1.22	1.22	0.82
ESTAR Clothes Washers	0.95	0.81	0.42
Future Elec Improvement	0.21	0.21	0.16
Outdoor Temp Reset	0.21	0.21	0.14
Prog. Thermostats (Central)	0.15	0.15	0.10
Power Bars (PCs)	0.15	0.15	0.11
ESTAR TVs	0.11	0.11	0.08
Wall Insulation	0.11	0.11	0.07
LED Lamps	0.11	0.12	0.05
ESTAR Refrigerators	0.11	0.10	0.08
ESTAR Printers and Fax	0.10	0.10	0.07
Power Bars (TVs)	0.09	0.09	0.06
Prog. Thermostats	0.08	0.08	0.05
Furnace Motors	0.07	0.07	0.07
Car Warmer Timers	0.07	0.08	0.00
Attic Insulation	0.06	0.06	0.04
Ground Heat Pumps - Closed	0.06	0.06	0.04
Battery Blanket Timers	0.05	0.06	0.00
Showerheads	0.05	0.06	0.14
Solar Pre-heat Makeup Air	0.05	0.05	0.03
DHW Recirculation	0.05	0.05	0.14
Sealing & Insul. - Old Homes	0.04	0.04	0.03
DHW Piping Optimization	0.04	0.05	0.12
ESTAR Freezers	0.04	0.04	0.03
ESTAR Dishwashers	0.03	0.04	0.08
Pulse start metal halide sentinel lights	0.03	0.03	0.03
DHW Tank Insulation	0.03	0.03	0.09
Air Sealing	0.03	0.03	0.02
Hot Tub Pump Timers	0.03	0.03	0.02
Heat Pump Spa Heaters	0.03	0.02	0.02
DHW Pipe Insulation	0.02	0.03	0.07
T8 Fixtures	0.02	0.02	0.01
LED Holiday - Outdoor	0.02	0.02	0.00
Wastewater Heat Recovery	0.01	0.02	0.04
LED Holiday - Indoor	0.01	0.01	0.00
Spa Pumps	0.01	0.01	0.01
Triple-glazed Windows	0.01	0.01	0.01
HRVs	0.01	0.01	0.01
Spot or Task Lighting	0.01	0.01	0.00
Basement Insulation	0.01	0.01	0.00
Motion Detectors - Indoor	0.01	0.01	0.00
Slab Insulation	0.01	0.01	0.00
Solar Spa Pre-heat	0.00	0.00	0.00
Optimizing Glazing for Passive	0.00	0.00	0.00
Motion Detectors - Outdoor	0.00	0.00	0.00
Hot Tub Covers	0.00	0.00	0.00
Quadruple-glazed Windows	0.00	0.00	0.00
Crawl Space Insulation	0.00	0.00	0.00
Grand Total	9.90	10.17	5.80

10.6.3 Electric Peak Load Reductions Under the Lower Achievable Potential Scenario

Exhibit 63 presents a summary of the peak load reductions that would occur as a result of the electric energy savings contained in lower Achievable Potential forecast. The reductions are shown by milestone year and peak period. In each case, the reductions are an average value over the peak period and are defined relative to the Reference Case presented previously in Section 4. Exhibit 64 shows the same information graphically for the Annual Peak Hour.

As discussed in Section 8.7, Exhibit 63 and Exhibit 64 approximate the potential demand impacts associated with the energy-efficiency measures because they are based on the assumption that the measures do not change the load shape of the end uses they affect. Exhibit 65, which shows the demand reductions associated with each electric energy savings measure, uses a more appropriate estimate of block heater load reduction that accounts for the fact that use of the timer both reduces electric energy use and changes the shape of the block heater load.

Exhibit 63 Electric Peak Load Reductions from Lower Achievable Energy Savings Measures, by Milestone Year, Peak Period and Dwelling Type (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	2015	0.6	0.6	0.4
	2020	1.8	1.8	1.2
	2025	3.0	2.9	2.0
	2030	4.5	4.5	3.0
Apartment/Condo Buildings	2015	0.0	0.1	0.0
	2020	0.2	0.2	0.1
	2025	0.4	0.4	0.2
	2030	1.0	1.0	0.6
Attached/Row Houses	2015	0.1	0.1	0.0
	2020	0.2	0.2	0.1
	2025	0.4	0.4	0.2
	2030	0.6	0.6	0.4
Mobile Homes	2015	0.0	0.0	0.0
	2020	0.1	0.1	0.1
	2025	0.1	0.1	0.1
	2030	0.3	0.3	0.2
Sentinel Lighting	2015	0.00	0.00	0.00
	2020	0.01	0.01	0.01
	2025	0.02	0.02	0.02
	2030	0.03	0.03	0.03
Seasonal and Garages	2015	0.01	0.01	0.00
	2020	0.02	0.02	0.01
	2025	0.01	0.02	0.00
	2030	0.02	0.02	0.00
Small Grid Housing	2015	0.00	0.00	0.00
	2020	0.01	0.01	0.01
	2025	0.01	0.01	0.01
	2030	0.02	0.02	0.01
Grand Total	2015	0.8	0.8	0.5
	2020	2.3	2.3	1.5
	2025	3.9	3.9	2.6
	2030	6.4	6.4	4.2

Exhibit 64 Electric Peak Load Reductions from Lower Achievable Energy Savings Measures, by Milestone Year and Dwelling Type, Annual Peak Hour (MW)

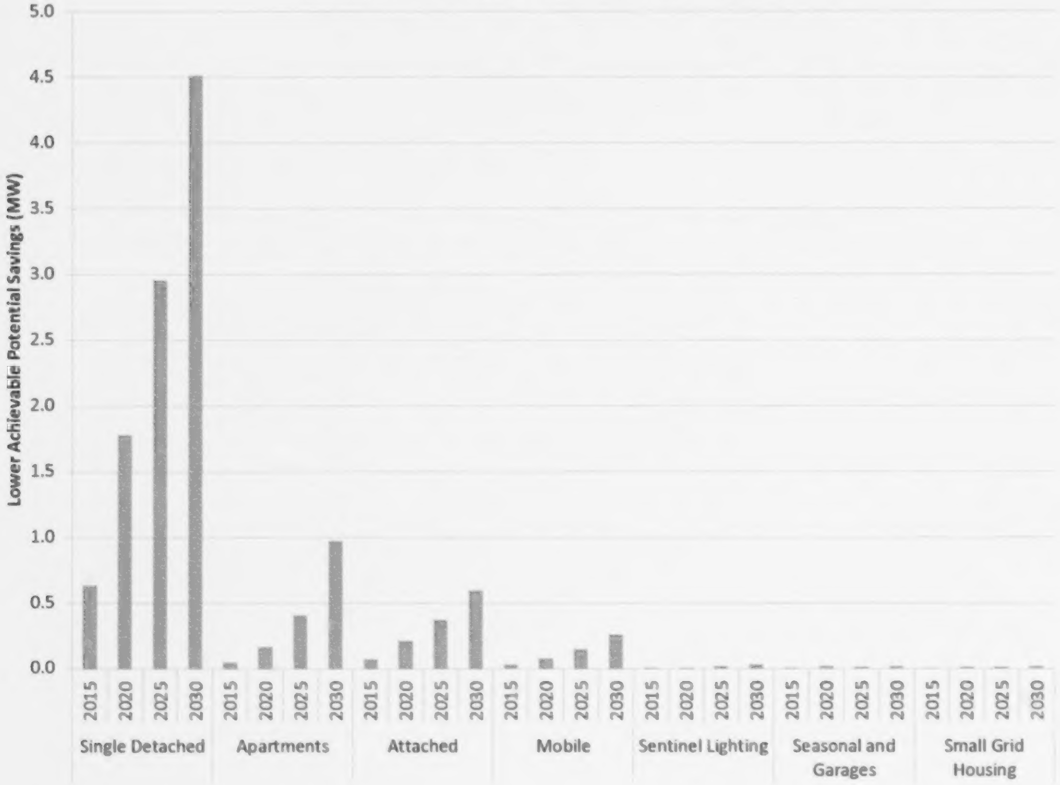

Exhibit 65 Electric Peak Load Reductions from Lower Achievable Energy Savings Measures, 2030 (MW)

Measure	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
High-Perf. New Homes	2.38	2.33	0.02
Block Heater Timers	1.23	1.54	0.00
ESTAR Clothes Washers	0.72	0.61	0.17
LEED Apartments	0.61	0.61	0.41
Zone Heating	0.54	0.53	0.35
Future Elec Improvement	0.11	0.11	0.03
Outdoor Temp Reset	0.09	0.09	0.06
LED Lamps	0.09	0.10	0.04
Power Bars (PCs)	0.07	0.08	0.06
Prog. Thermostats (Central)	0.06	0.06	0.04
ESTAR Refrigerators	0.05	0.05	0.02
Car Warmer Timers	0.05	0.06	0.00
Power Bars (TVs)	0.04	0.04	0.03
ESTAR TVs	0.04	0.04	0.04
Showerheads	0.04	0.04	0.11
Battery Blanket Timers	0.04	0.05	0.00
Ground Heat Pumps - Closed	0.03	0.03	0.08
ESTAR Printers and Fax	0.03	0.03	0.02
Pulse start metal halide sentinel lights	0.03	0.03	0.03
Furnace Motors	0.03	0.03	0.03
Prog. Thermostats	0.03	0.03	0.02
Solar Pre-heat Makeup Air	0.02	0.02	0.02
ESTAR Freezers	0.02	0.02	0.03
DHW Tank Insulation	0.02	0.03	0.03
LED Holiday - Outdoor	0.02	0.02	0.00
Wall Insulation	0.02	0.02	0.01
Hot Tub Pump Timers	0.02	0.02	0.02
DHW Pipe Insulation	0.02	0.02	0.00
Heat Pump Spa Heaters	0.02	0.02	0.02
T8 Fixtures	0.02	0.02	0.01
ESTAR Dishwashers	0.01	0.02	0.31
Attic Insulation	0.01	0.01	0.00
LED Holiday - Indoor	0.01	0.01	0.00
Spa Pumps	0.01	0.01	0.01
DHW Recirculation	0.01	0.01	0.02
Sealing & Insul. - Old Homes	0.01	0.01	0.01
DHW Piping Optimization	0.01	0.01	0.05
Air Sealing	0.00	0.00	1.72
Spot or Task Lighting	0.00	0.00	0.00
HRVs	0.00	0.00	0.00
Motion Detectors - Indoor	0.00	0.00	0.00
Solar Spa Pre-heat	0.00	0.00	0.00
Wastewater Heat Recovery	0.00	0.00	0.01
Triple-glazed Windows	0.00	0.00	0.00
Hot Tub Covers	0.00	0.00	0.00
Motion Detectors - Outdoor	0.00	0.00	0.00
Basement Insulation	0.00	0.00	0.01
Slab Insulation	0.00	0.00	0.00
Optimizing Glazing for Passive	0.00	0.00	0.00
Quadruple-glazed Windows	0.00	0.00	0.00
Crawl Space Insulation	0.00	0.00	0.55
Grand Total	6.60	6.78	4.37

11 References

The sources listed below include references used in preparation of this report and additional resources likely to be helpful for research on energy consumption patterns and efficient technologies. Additional references on specific technologies may be found in the TRC Analysis Workbooks, supplied as an accompanying deliverable with this report.

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12 Glossary

Achievable Potential:

The portion of the economic conservation potential that is achievable through government and utility interventions and programs given institutional, economic and market barriers.

Avoided Cost:

By reducing electricity consumption and capacity requirements through the implementation of demand-side management programs, the Yukon utilities avoid the cost of having to buy electricity on the open market, contract for long term supply, and/or build and run new generation facilities. This avoided cost is used to develop a benchmark against which the cost of energy efficiency measures can be compared.

Base Year:

The base year for the 2011 CPR is the 2010 sales for the two utilities. This number is derived from 2010 sales and forecast 2010 electric energy and capacity requirements as is explained in each report.

Benchmark for Economic Analysis:

The study established benchmarks for the economic cut-off for new avoided electrical supply on each of the four different supply systems in Yukon. These values were selected to provide the CPR study with a reasonably useful time horizon (life) to allow planners to examine options that may become more cost-effective over time. The following values were used:

- Residential accounts on the Hydro Grid: $0.35/kWh
- Residential accounts on Large Diesel and Small Diesel systems: $0.30/kWh
- Residential accounts on the Old Crow system: $0.64/kWh.

Cost of Conserved Energy (CCE):

The CCE is calculated for each energy-efficiency measure. The CCE is the annualized incremental capital and operating and maintenance (O&M) cost of the upgrade measure divided by the annual energy savings achieved, excluding any administrative or program costs. The CCE represents the cost of conserving one kWh of electricity; it can be compared directly to the cost of supplying one new kWh of electricity.

Cost of Electric Peak Reduction (CEPR):

The CEPR for a peak load reduction measure is defined as the annualized incremental capital and O&M cost of the measure divided by the annual peak reduction achieved, excluding any administrative or program costs. The CEPR represents the cost of reducing one kW of electricity during a peak period; it can be compared to the cost of supplying one new kW of electric capacity during the same period.

Demand-side Management (DSM):

DSM is the influencing of customers' electricity use to obtain desirable and quantifiable changes in that use. For example, DSM comprises such cooperative joint customer and utility initiatives as peak clipping, valley filling, load shifting, strategic conservation, strategic load growth, flexible load shape, customer on-site generation and other similar activities.

Economic Potential:
The Economic Potential is the savings in electricity consumption due to energy efficient measures whose Cost of Conserved Energy (CCE) is less than or equal to the Benchmark for Economic Analysis.

Effective Measure Life (EML):
The estimated median number of years that the measures installed under a program are still in place and operable. EML incorporates: field conditions, obsolescence, building remodelling, renovation, demolition, and occupancy changes.

Electricity Audit:
An on-site inspection and cataloguing of electricity-using equipment/buildings, electricity consumption and the related end uses. The purpose is to provide information to the customer and the utility. Audits are useful for load research, for DSM program design, and identifying specific energy savings projects.

Electric Capacity:
The maximum electric power that a device or network is capable of producing or transferring.

Electricity Conservation:
Activities by utilities or electricity users that result in a reduction of electric energy use without adversely affecting the level or quality of energy service provided. Electricity conservation measures include substitution of high-efficiency motors for standard efficiency ones, occupancy sensors in office buildings, insulation in residences, etc.

Electricity Efficiency:
The ratio of the useful energy delivered by a dynamic system to the amount of electric energy supplied to it.

Electric Energy:
Energy in the form of electricity. Energy is the ability to perform work. Electric energy is different from electric power. Electric energy is measured in kilowatt-hours, megawatt-hours or gigawatt-hours.

Electricity Intensity:
Electric energy use measured per application or end use. Examples would include kilowatt-hours per square meter of lit office space per day, kilowatt-hours per tonne of potash produced, and kilowatt-hours per year per residential refrigerator. Electricity intensity increases as electricity efficiency decreases.

Electric Power:
The rate at which electric energy is produced or transferred, usually measured in watts, kilowatts and megawatts.

End use:
The services of economic value to the users of energy. For example, office lighting is an end use, whereas electricity sold to the office tenant is of no value without the equipment (light fixtures, wiring, etc.) necessary to convert the electricity into visible light. End use is often used interchangeably with energy service.

Energy Service:
An amenity or service supplied jointly by energy and other components such as buildings, motors and lights. Examples of energy services include residential space heating, commercial refrigeration, natural gas production, and lighting. The same energy service can frequently be supplied with different mixes of equipment and energy.

Financial Incentive:
Certain financial features in the utility's demand-side management programs designed to motivate customer participation. These may include features designed to reduce a customer's net cash outlay, pay-back period or cost of finance to participate in a specific demand-side management measure or technology.

Flexible Load Shape:
This is utility action to present customers with variations in service quality in exchange for incentives. Programs involved may be variations of interruptible or curtail-able load, concepts of pooled, integrated energy management systems, or individual customer load control devices offering service constraints.

Gigawatt-hour (GWh):
One gigawatt-hour is one million kilowatt-hours.

Integrated Planning or Integrated Resource Planning (IRP):
See Supply Planning.

Integrated Electricity Planning (IEP):
See Supply Planning.

Kilowatt (kW):
One thousand watts; the basic unit of measurement of electric energy. One kilowatt-hour represents the power of one thousand watts (one kilowatt) for a period of one hour. A typical non-electrically heated detached home in Yukon uses about 12,800 kWh per year. A four foot fluorescent lamp in an office might use about 100-200 kWh per year and a large coal-fired plant might produce about three billion kWh per year.

Levelized Cost of Conservation (LCC):
The LCC is calculated for each energy efficiency measure. The LCC is the annualized incremental capital and O&M cost of the measure divided by the annual energy conserved, excluding any administrative or program costs. The LCC represents the cost of generating or conserving one kWh of electricity; it can be compared directly to the cost of supplying one new kWh of electricity. In the context of residential energy efficiency measures, it is essentially the same as the cost of conserved energy (CCE), which is the term used in this report.

Load Forecast:
This is a forecast of electricity demand over a specified time period. Long-term load forecasts usually pertain to a 10 to 20-year period. In the case of Yukon, the load forecast assumes a specific set of rates or prices for electricity and competing energy forms, as well as many other economic variables. In addition, forecasts of electricity conserved through DSM programs are incorporated into the Supply Planning process.

Load Research:
Research to disaggregate and analyze patterns of electricity consumption by various sub-sectors and end uses is defined as load research. Load research supports the development of the load forecast and the design of demand-side management programs.

Load Shape:
The time pattern and magnitude of a utility's electrical demand.

Load Shifting:
Utility program activity to shift demand from peak to off-peak periods is defined as load shifting.

Measure Total Resource Cost (TRC):
The measure TRC calculates the net present value of energy savings that result from an investment in an energy-efficiency measure. The measure TRC is equal to its full or incremental capital cost (depending on application) plus any change (positive or negative) in the combined annual energy and O&M costs. This calculation includes, among others, the following inputs: the avoided electricity supply costs, the life of the technology, and the selected discount rate, which in this analysis has been set at 5.25%.

A measure with a positive measure TRC value is included in subsequent stages of the analysis, which consists of the Economic and Achievable Potential scenarios. A measure with a negative TRC value is not economically attractive and is therefore not included in subsequent stages of the analysis.

Megawatt (MW):
One thousand kilowatts.

Natural Change in Electricity Intensity:
The future change in electricity intensity in a given end use that is expected to occur in the absence of demand-side management programs. In developing an estimate of natural change in electricity intensity it is necessary to make an explicit assumption about the future prices of electricity and competing fuels.

Peak Clipping:
Utility program activity to reduce peak demand without reducing demand at other times of the day or year.

Peak Demand:
Peak demand is the maximum electric power required by a customer or electric system during a short time period, typically one hour. The peak is the time (usually of day or year) at which peak demand occurs.

Rate Structure:
The formulas used to calculate charges for the use of electricity. For example, the present rate structures for both Yukon utilities for residential customers consist of a fixed monthly charge and charges for electric energy usage, where the rate per kilowatt-hour depends on the level of consumption. Some rate structures charge for peak usage as well as electric energy usage.

Reference Case:
Provides a forecast of electricity sales that includes natural conservation (that which would occur in the absence of DSM programs) but no impacts of utility DSM programs. The reference case for the study is based on the 2010 YECL Load Forecast.

Sector:

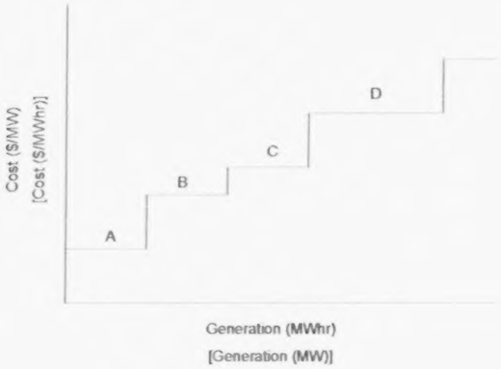
A group of customers having a common type of economic activity. This CPR studies the Residential and Commercial sectors.

Sub sectors:

A classification of customers within a sector by common features. Residential sub sectors are by type of home (single-family dwelling or apartment). Commercial sub sectors are generally by type of commercial service (retail and wholesale trade).

Supply Curves:

A graph that depicts the volume of energy at the appropriate screened price in ascending order of cost. Steps A through D below represent programs options, or technologies arranged as a supply curve.



Supply Planning:

The process of long-term planning of electricity generation and associated transmission facilities, in combination with supply reductions made possible through demand-side management, in order to meet forecast demands. Supply Planning in Yukon is done in a framework that recognizes economic, financial, environmental and social costs, risks, and impacts.

Supply System:

Electricity is supplied by YEC and YECL to customers using four different supply systems, which vary in terms of retail rates and generation costs. The four different systems are as follows:

- Hydro Grid: All customers of YEC and most customers of YECL are connected to a grid that is served primarily by hydroelectricity
- Large Diesel: YECL customers in Watson Lake are served by a large diesel grid
- Small Diesel: YECL customers in Destruction Bay/Burwash, Beaver Creek, and Swift River are served by three small diesel grids
- Old Crow: YECL customers in Old Crow are served by a diesel grid for which the fuel must be flown into the community.

Technical Efficiency:
Efficiency of a system, process, or device in achieving a certain purpose, measured in terms of the physical inputs required to produce a given output. In the context of electricity conservation the relevant input is electric energy.

Technology-Based Potential:
Energy and or capacity/demand savings realized through the implementation of energy-efficiency technologies.

Watt:
The basic unit of measurement of electric power.

Yukon Service Area:
Yukon Service Area is the territory of Yukon. This includes all customers served by YEC or YECL, including those connected to the hydro grid as well as customers on the large and small diesel supply systems, and the system serving the fly-in community of Old Crow.

Appendix A Background-Section 3: Base Year Electricity Use

Introduction

Appendix A provides additional detailed information related to each of the major steps employed to generate the profile of Residential sector Base Year electricity use. The major steps involved are:

- Step 1: Determine net space heating and cooling loads for each existing dwelling type
- Step 2: Determine annual electricity use for the existing stock of major residential appliances
- Step 3: Determine appliance saturation levels for each dwelling type
- Step 4: Determine electricity share for each appliance, by dwelling type
- Step 5: Calibrate to sales data for the study Base Year of 2010.

A.1 Step 1: Determine Net Space Heating Loads

Net space heating load is the space heating load of a building that must be met by the space heating system. This is equal to the total heat loss through the building envelope minus solar and internal gains. The net space heating loads for each dwelling type were developed based on the following combination of data sources:

- Marbek's database of residential energy consumption from other jurisdictions
- Current utility sales data combined with knowledge of the electricity consumption and saturation of other end uses.

The net space heating load for each dwelling type is given by the following equation:

$NetHL_1 = HL_1 + a_{i,1} * s_{i,1}$

Where:
$NetHL_1$ = Net heating load for dwelling type #1
HL_1 = Load on primary heating appliance for dwelling type #1
$a_{i,1}$ = Average consumption for supplementary heating in dwelling type #1
$s_{i,1}$ = Saturation of supplementary heating in dwelling type #1

HL_1 was estimated for each dwelling type and service region, based on utility customer sales data for electrically and non-electrically heated dwellings combined with data on the electricity consumption of non-space heating end uses. The values for a_{i1} and s_{i1} were developed based on the estimated share of space heating that is provided by electricity (versus supplementary fuels), as taken from the Residential Electrical End Use Survey (REEUS). The net space heating loads are presented in Exhibit A 1.

It should be noted that the values shown in Exhibit A 1are not fuel specific; rather, they represent the total tertiary space heat load for each dwelling. The efficiency of the space heating appliances used to meet these loads is considered in subsequent stages of the analysis.

Exhibit A 1 Existing Residential Units, 2010, Net Space Heating Loads by Dwelling Type (kWh/yr.)

Dwelling Types	Tertiary Heating Load (kWh/yr.)			
	Hydro Grid	Large Diesel	Small Diesel	Old Crow
1980 & newer non-electrically heated single detached homes	20,538	19,866	-	-
Pre-1980 non-electrically heated single detached homes	28,753	27,813	-	-
1980 & newer electrically heated single detached homes	13,555	-	-	-
Pre-1980 electrically heated single detached homes	16,677	-	-	-
1980 & newer non-electrically heated attached/row housing	13,117	12,688	-	-
Pre-1980 non-electrically heated attached/row housing	17,971	17,383	-	-
1980 & newer electrically heated attached/row housing	7,411	-	-	-
Pre-1980 electrically heated attached/row housing	10,153	-	-	-
Non-electrically heated apartment units	10,380	8,535	-	-
Non-electrically heated apartment common areas	25,291	29,287	-	-
Electrically heated apartment units	6,021	-	-	-
Electrically heated apartment common areas	14,669	-	-	-
Non-electrically heated mobile/other	17,014	25,156	-	-
Electrically heated mobile/other	10,490	-	-	-
Small diesel grid housing	-	-	16,179	17,937
Seasonal housing	1,409	1,480	1,098	1,172
Residential garages	10,006	7,104	4,002	10,006

A.1.1 Development of Thermal Archetypes – Existing Stock

The next major step involved the development of a thermal archetype for each of the major dwelling types noted in Exhibit A 1 using HOT2000.

Each HOT2000 file contains a comprehensive physical description of the size, layout and thermal characteristics of each dwelling type. HOT2000 then uses these inputs to create a full computer model of the residence, calculating loads, interactive effects and energy consumption. In each case, the net heating and cooling loads simulated by HOT2000 were calibrated to the values shown in Exhibit A 1, which had been established on the basis of the sources described above. The process of calibrating simulation models to the loads estimated from available data served to further confirm the estimated loads. Adjustments were made to the estimates as required.

The physical and operating characteristics of each residential thermal archetype were researched using a number of sources, including:

- Database of EnerGuide for Houses (EGH) evaluations in Yukon provided by Yukon Housing Corporation
- Natural Resources Canada (NRCan) and Statistics Canada housing data
- Consultations with energy auditors and residential housing experts located in Yukon.

For the existing housing stock, archetypes were created for the two primary dwelling types in each service region: single-family detached and attached. A brief description of each housing archetype is provided below.

Single detached houses

A "typical" pre-1980 single-family detached dwelling can be defined as a single-story bungalow of approximately 170 m^2 (1,800 ft^2), including a finished basement. This home has 16.5 m^2 (177.5 ft^2) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.46 (R-14) insulation values, ceilings RSI-4.93 (R-28) and the basement is insulated to a value of RSI-2.29 (R-13) all the way to the basement floor. The houses are typically not very airtight, with an air change rate of about 6.0 ACH@50Pa (air changes per hour at 50 Pascal depressurization).

Typical newer dwellings (built since 1980) are approximately the same size as above. They tend to have more windows, approximately 19.0 m^2 (205 ft^2) of window area, but these are typically of higher performance, typically defined as low-e, argon-filled, double-glazed, mostly with vinyl frames. Walls are represented by RSI-2.99 (R-17) insulation values, ceilings RSI-5.98 (R-34) and the basement is insulated to a value of RSI-2.99 (R-17) all the way to the basement floor. The houses are more airtight, with an air change rate of about 5 ACH@50Pa.

Attached Dwellings

An average attached dwelling can be defined as a one-story end unit of approximately 125 m^2 (1,350 ft^2), including a finished basement. This home has 11.5 m^2 (125 ft^2) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.81 (R-16) insulation values, ceilings RSI-5.98 (R-34) and the basement is insulated to a value of RSI-2.46 (R-14) all the way to the basement floor. The houses are somewhat airtight, with an air change rate of about 5 ACH@50Pa.

A.2 Step 2: Determine Annual Appliance Electricity Use

The next major task involved the development of estimated average annual unit electricity consumption (UEC) values for each of the major residential appliances.

Electrical consumption of appliances is related to age. According to NRCan data[29] most appliances have increased in efficiency over time. Estimates of the evolving energy consumption of the stock of appliances in Yukon were developed using an appliance stock model that takes into account the expected useful life of each type of appliance, the rate of purchase and retirement of appliances, the average annual consumption of newly purchased appliances in a given year, and the average annual consumption of appliances being retired in a given year. The stock average consumption thus evolves with time. In any specific year, the average age of appliances in place is assumed to be half of the expected useful life of the appliance and the stock average is built up of all the appliances purchased and installed up to that point.

There is some evidence of a correlation between age of dwelling and age of the appliances in it, but it is not a strong relationship. Older homes likely have had major appliances replaced several times and newer homes can have old appliances transferred from previous residences. The difference in appliance electrical consumption as related to the age of the home was judged small enough to be neglected for the purposes of this study.

A more important driver of appliance electricity consumption is the difference in average number of occupants in different types of homes. This influences the size of some appliances, such as refrigerators, and the intensity of use for others, such as laundry and cooking appliances. The estimated annual electricity consumption of appliances by dwelling type reflects these differences.

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[29] NRCan, 2008. *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2006.*

Exhibit A 2 summarizes the estimated average annual UEC for the current stock mix of major end-use appliances, for accounts connected with the hydro grid.

The space heating end use has been omitted from Exhibit A 2 because it was presented in Exhibit A 1.

Exhibit A 2 Annual Appliance Unit Electricity Consumption (UEC), Hydro Grid Accounts (kWh/yr.)

Dwelling Types	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	602	3,453	1,029	288	28	716	638	461	116
Pre-1980 non-electrically heated single detached homes	610	3,453	1,029	288	28	716	638	461	116
1980 & newer electrically heated single detached homes	100	3,453	1,029	288	28	716	638	461	116
Pre-1980 electrically heated single detached homes	100	3,453	1,029	288	28	716	638	461	116
1980 & newer non-electrically heated attached/row housing	463	2,724	698	189	14	478	521	376	77
Pre-1980 non-electrically heated attached/row housing	469	2,724	698	189	14	478	521	376	77
1980 & newer electrically heated attached/row housing	100	2,724	698	189	14	478	521	376	77
Pre-1980 electrically heated attached/row housing	100	2,724	698	189	14	478	521	376	77
Non-electrically heated apartment units	359	1,483	499	54	6	411	526	380	66
Non-electrically heated apartment common areas	4,385	24,119	6,101	660	72	-	-	-	-
Electrically heated apartment units	50	1,483	499	54	6	411	526	380	66
Electrically heated apartment common areas	611	18,134	6,101	660	72	-	-	-	-
Non-electrically heated mobile/other	469	2,724	698	189	14	478	521	376	77
Electrically heated mobile/other	100	2,724	698	189	14	478	521	376	77
Small diesel grid housing	610	3,453	1,029	288	28	716	638	461	116
Seasonal housing	30	583	174	49	-	121	108	78	20
Residential garages	366	-	617	173	-	-	-	78	-
Sentinel Lighting	-	-	-	645	-	-	-	-	-

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other
1980 & newer non-electrically heated single detached homes	65	990	12,468	394	178	225	106	258	258	186
Pre-1980 non-electrically heated single detached homes	65	990	12,468	394	178	225	106	258	258	186
1980 & newer electrically heated single detached homes	65	990	12,468	394	178	225	106	258	258	186
Pre-1980 electrically heated single detached homes	65	990	12,468	394	178	225	106	258	258	186
1980 & newer non-electrically heated attached/row housing	43	660	12,468	394	178	225	72	258	258	126
Pre-1980 non-electrically heated attached/row housing	43	660	12,468	394	178	225	72	258	258	126
1980 & newer electrically heated attached/row housing	43	660	12,468	394	178	225	72	258	258	126
Pre-1980 electrically heated attached/row housing	43	660	12,468	394	178	225	72	258	258	126
Non-electrically heated apartment units	37	567	-	394	178	225	61	-	-	107
Non-electrically heated apartment common areas	457	6,938	24,936	-	-	-	-	3,151	3,151	-
Electrically heated apartment units	37	567	-	394	178	225	61	-	-	107
Electrically heated apartment common areas	457	6,938	24,936	-	-	-	-	3,151	3,151	-
Non-electrically heated mobile/other	43	660	12,468	394	178	225	72	258	258	126
Electrically heated mobile/other	43	660	12,468	394	178	225	72	258	258	126
Small diesel grid housing	65	990	12,468	394	178	225	106	258	258	186
Seasonal housing	11	167	6,234	67	30	38	18	-	-	31
Residential garages	-	-	-	-	-	-	-	258	258	1,200
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-

Occupancy

Occupancy rates[30] for each dwelling type were based on national Census data[31]. They are used, as applicable, to estimate electricity use for occupant-sensitive end uses, such as DHW, laundry and lighting. Exhibit A 3 summarizes the occupancy rates assumed for this study.

Exhibit A 3 Occupancy Rates by Dwelling Type

Household Sizes	Single Detached Houses	Double/Row Houses	Apartments	Mobile Homes
1 member	14%	23%	58%	36%
2 members	37%	36%	33%	64%
3 members	18%	18%	6%	0%
4 or more members	31%	23%	4%	0%
Approximate Average	2.7	2.4	1.6	1.6

Ventilation and Circulation

Ventilation electricity is associated with fan/blower electricity in heating systems, kitchen fans, bathroom fans and heat recovery ventilators.

A furnace fan UEC of approximately 510 kWh was assumed for single detached houses with forced air systems. This figure is consistent with estimates used in ICF Marbek's most recent studies in other jurisdictions and is somewhat lower than estimates used in earlier studies. This reflects the steady increase in the prevalence of ECM motors. The value is also consistent with the range of Canadian end-use metered data reported in a study conducted for Natural Resources Canada.[32]

For the purpose of estimating kitchen and bathroom fan electricity, it was assumed that a typical exhaust fan is rated at 75 Watts and operates, on average, for two hours per day. In homes with heat supplied by baseboard electric or by hydronic systems, these exhaust fans are the predominant ventilation load. With two such fans in a typical house, consumption would be approximately 100-110 kWh/yr.

The UEC for a forced air system includes the electricity consumed by both the furnace fan and the exhaust fans. The UEC for a baseboard electric system includes only the electricity consumed by the latter.

Note: The ventilation and circulation UEC values shown previously in Exhibit A 2 reflect the mix between forced air systems and baseboard systems.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, ventilation and circulation UEC was scaled according to tertiary heating load.

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[30] Electricity use related to personal consumption increases with number of occupants in dwelling.

[31] NRCan, 2007. *Survey of Household Energy Use 2007: Detailed Statistical Report.*

[32] This area is the focus of extensive research efforts. *See:* Gusdorf, John, *Final Report on the Project to Measure the Effects of ECM Furnace Motors on Gas Use at the CCHT Research Facility*, Natural Resources Canada, January 2003. Current estimates of fan energy use vary widely; upper range estimates (heat mode only) exceed 1,000 kWh/yr. Continuous ventilation or use with space cooling equipment would increase fan motor consumption.

Domestic Hot Water

UEC estimates for DHW assume a per capita hot water consumption of 45 litres per person per day and a temperature rise of 45°C. Exhibit A 4 shows the distribution of DHW load by major end use.

Exhibit A 4 Distribution of DHW Electricity Use by End Use in Existing Stock, (kWh/yr.)

DHW Sub End Uses	Electricity per Sub End Use (kWh/yr.)	Electricity per Sub End Use (%)
Clothes Washer	631	18%
Showers	897	26%
Faucets	641	19%
Baths	128	4%
Dishwasher	451	13%
Leaks	192	6%
Tank (Standby) Losses	256	7%
Pipe Losses	256	7%
Total	3,453	100%

Note: Any differences in totals are due to rounding.

The DHW values shown in Exhibit A 4 are based on a combination of sources including available data from other jurisdictions, NRCan studies (NRCan, 2005) and the results of other recent ICF Marbek studies.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, DHW and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Indoor Lighting

The indoor lighting loads shown in Exhibit A 2 were developed from the following sources:

- Residential utility data on lighting types and usage patterns from other jurisdictions
- Yukon's REEUS
- NRCan's End Use Energy Data Handbook (NRCan, 2005).

Exhibit A 5 shows the estimated counts of different types of lighting based on the data from the REEUS and residential lighting data from other ICF Marbek studies. Lighting counts have increased as larger houses have been built in Canada, but the hours of use for each lighting fixture has decreased at the same time.

The average wattage and hours of use per year shown in the exhibit are based on Marbek's energy use database, developed during several previous conservation potential studies. They were adjusted for consistency with the sources listed above. The resulting calculation shown in the exhibit provides a basis for the estimate of overall indoor lighting energy consumption for different dwelling types.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, lighting and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 5 Indoor Lighting by Dwelling Type

Dwelling Types	Incandescent Lamps	Linear Fluorescent Tubes	Compact Fluorescent Lamps	Halogen Lamps	
SDH	23	6	16	3	(lamps)
Attached	17	2	12	2	(lamps)
Apartment	13	1	8	1	(lamps)
Average Wattage	60	48	15	50	(watts)
Average Hours/Year	500	500	500	500	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	690	144	120	75	1029
Attached	510	48	90	50	698
Apartment	390	24	60	25	499

Outdoor Lighting

The outdoor lighting loads shown in Exhibit A 2 were developed from the following sources:

- Residential utility data on lighting types and usage patterns from other jurisdictions
- Yukon's REEUS
- NRCan's End Use Energy Data Handbook (NRCan, 2005).

Exhibit A 6 shows the estimated counts of different types of lighting based on the data from the REEUS and residential lighting data from other ICF Marbek studies.

The average wattage and hours of use per year shown in the exhibit are based on Marbek's energy use database, developed during several previous conservation potential studies. They were adjusted for consistency with the sources listed above. The resulting calculation shown in the exhibit provides a basis for the estimate of overall outdoor lighting energy consumption for different dwelling types.

For the accounts connected to the large and small diesel and Old Crow systems, lighting and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 6 Outdoor Lighting by Dwelling Type

Dwelling Types	Incandescent Lamps	Linear Fluorescent Tubes	Compact Fluorescent Lamps	
SDH	4	1	2	(lamps)
Attached	3	0	1	(lamps)
Apartment	1	0	0	(lamps)
Average Wattage	60	48	15	(watts)
Average Hours/Year	900	365	1800	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)				Total
SDH	216	18	54	288
Attached	162	0	27	189
Apartment	54	0	0	54

Holiday Lighting

The holiday lighting loads shown in Exhibit A 2 were developed from the following sources:

- Residential utility data on lighting types and usage patterns from other jurisdictions
- Yukon's REEUS
- NRCan's End Use Energy Data Handbook (NRCan, 2005).

Exhibit A 7 shows the estimated counts of different types of holiday lighting based on the data from the REEUS and residential lighting data from other ICF Marbek studies.

The average wattage and hours of use per year shown in the exhibit are based on Marbek's energy use database, developed during several previous conservation potential studies. They were adjusted for consistency with the sources listed above. The resulting calculation shown in the exhibit provides a basis for the estimate of overall holiday lighting energy consumption for different dwelling types.

For the accounts connected to the large and small diesel and Old Crow systems, lighting and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 7 Holiday Lighting by Dwelling Type

Dwelling Types	Indoor Incandescent Holiday Strings	Indoor LED Holiday Strings	Outdoor Incandescent Holiday Strings	Outdoor LED Holiday Strings	
SDH	2	9	2	6	(lamps)
Attached	1	5	1	4	(lamps)
Apartment	1	2	0	0	(lamps)
Average Wattage	60	1	60	1	(watts)
Average Hours/Year	95	95	125	125	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	11	1	15	1	28
Attached	6	0	8	1	14
Apartment	6	0	0	0	6

Cooking Appliances, Refrigerator, Freezer and Dishwasher

UEC estimates for the existing stock of this group of food preparation and storage appliances were obtained from *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2006* (NRCan, 2008). The values shown for dishwashers are for mechanical electricity only; hot water use is included with the DHW UEC.

For the accounts connected to the large and small diesel and Old Crow systems, appliances and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Clothes Washer and Dryer

Appliance UEC data was obtained from *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2006* (NRCan, 2008). The values shown for clothes washers are for mechanical electricity only; hot water use is included with the DHW UEC.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, appliances and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Computers

UEC data for computers is based on calculations drawing on data from the *Survey of Household Energy Use 2007: Detailed Statistical Report* (NRCan, 2007) and is consistent with Marbek's previous work for BC Hydro.[33]

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, electronics and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

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[33] Marbek Resource Consultants, *Conservation Potential Review – 2007*. Prepared for BC Hydro. 2007.

Television

UEC data for televisions was obtained from *Technology and Market Profile: Consumer Electronics* (Marbek, 2006). Saturation of televisions (number of sets per household) is adjusted by dwelling type based on data from the REEUS but consumption per television is not varied by dwelling type in this study.

For the accounts connected to the large and small diesel and Old Crow systems, electronics and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Television Peripherals

UECs, saturations and numbers per household for television peripherals were obtained from *Technology and Market Profile: Consumer Electronics* (Marbek, 2006) and other published data. In some parts of Canada, internet protocol television (IP-TV) is becoming a major player in the marketplace. The equipment for IP-TV uses about 40% less than the average cable or satellite system. IP-TV is assumed to occupy only a very small part of the Yukon market at this time, and has not been included in the calculations for this study. The weighted UEC for this end use as a whole was generated from the numbers shown in Exhibit A 8. UEC is not varied by dwelling type in this study.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, electronics and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 8 Derivation of UEC for Television Peripherals

	% of TV households	UEC kWh/yr.
Digital Cable Service	38%	
Digital Adaptor	38%	82
Standard Digital STB	31%	194
Advanced Digital STB	7%	325
Average UEC		299
Satellite Service	47%	
Standard Satellite STB	38%	141
Advanced Satellite STB	9%	273
Average UEC		166
Total Weighted UEC		226

Home Entertainment Electronics

Due to the large presence of electronic entertainment devices in many residential dwellings, this end use was separated from the general "other" category. UECs were obtained from *Technology and Market Profile: Consumer Electronics* (Marbek, 2006), *Residential Miscellaneous Electricity Use* (LBL) and other published data. A weighted UEC for the end use as a whole was generated based on recent ICF Marbek studies, as shown in Exhibit A 9.

For the accounts connected to the large and small diesel and Old Crow systems, electronics and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 9 Derivation of UECs for Other Electronics

	Penetration	Number Per Household	UEC (kWh/yr.)	Weighted UEC (kWh/yr.)
DVD	72%	1.2	35	30
VCR	69%	1.3	55	49
Audio System	29%	1.3	55	21
Surround Sound	25%	1.0	50	13
Compact Audio	79%	1.5	25	30
Game Console	25%	1.3	55	18
	Total Weighted UEC			160

Spas

This end use includes only spas. The incidence of swimming pools in Yukon is assumed to be small. The UEC includes the spa heater if it is electric, and also includes the consumption of the pump. Figures are derived from ICF Marbek's previous work in other jurisdictions and manufacturer literature on spa heater consumption. Exhibit A 10 shows the derivation of the UECs used in Exhibit A 2. The market penetration numbers in the exhibit are estimates of the shares of each technology within the subset of spas with that electric end use. For example, the estimate of 75% spa heaters using resistance heating elements is the share of electrically heated spas using resistance heat. Spas that are heated with propane or solar are not included. For the accounts connected to the large and small diesel and Old Crow systems, all non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 10 Derivation of UECs for Spas

	UEC (kWh/yr.)	Market Penetration	Weighted UEC (kWh/yr.)
Spa Heaters			
Resistance	13,341	75%	10,006
Heat Pump	4,447	25%	1,112
	Weighted UEC		11,118
Spa Pumps			
Standard	1,500	75%	1,125
High Efficiency	900	25%	225
	Weighted UEC		1,350
	Total Weighted UEC		12,468

Block Heaters and Car Warmers

Consumption for block heaters was based on previous studies in other jurisdictions. Block heaters typically draw 500 watts. They were assumed to be used an average of 6.7 hours/day for 90 days of the year. Approximately one-quarter of them were assumed to be on timers, which would reduce their runtime by 70%. The resulting total consumption of block heaters was estimated at 228 kWh/yr. The car warmers use more power, typically 1200 watts. They were assumed to be used for only about four hours per day, but over a longer season of 110 days.

More of them were assumed to be on timers – nearly half – with savings of about 50% of runtime. The resulting total consumption of car warmers was estimated at 400 kWh/yr. There are fewer car warmers than block heaters in use – approximately one car warmer for every 14 block heaters according to the Yukon REEUS. Therefore, the car warmers were assumed to add only about 30 kWh/yr. to the total consumption for this end use, bringing it to 258 kWh/yr.

Heat Tape, Propane Heaters, and Circulation Pumps

This end use includes electric plug-in devices for preventing water lines from freezing, including both heat tape and circulation pumps, and devices for warming outdoor propane tanks so the propane will flow easily. Because the devices included are so varied, it is difficult to estimate an overall annual consumption for the end use as a whole. The consumption for block heaters and car warmers, 258 kWh/yr., was used as an estimate.

Small Appliances and Other

"Other" end uses include a wide range of appliances and equipment found in most homes. Reliable data on the actual annual electricity use of this collection of appliances and equipment within Yukon is not available.

Exhibit A 11 illustrates the major items included in this end use and presents sample UEC data estimated in earlier studies undertaken in other jurisdictions.[34] It should be noted that actual UECs for individual appliances will vary from those shown in Exhibit A 11 and are affected by factors such as saturations by dwelling type and occupancy rates. Saturation information from LBL was not applied for this study because reliable information for Yukon was not available. The "other" category is not built up based on detailed analysis, but is an approximation only. The LBL data provided should be treated as being illustrative of the types of energy-using items in the category and how much electricity they typically use.

For the accounts connected to the large and small diesel and Old Crow systems, all non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

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[34] Lawrence Berkeley National Laboratory (LBL), *Residential Miscellaneous Electricity Use*, 1997.

Exhibit A 11 Typical UECs for Selected "Other" Appliances

Appliance	UEC (kWh/yr.)	Appliance	UEC (kWh/yr.)
Home radio, small/clock	18	Timer	18
Battery Charger	21	Hot Plate	30
Clock	18	Stand Mixers	1
Power Strip	3	Hand-Held Rechargeable	16
Vacuum	31	Hand-Held Electric Vacuum	4
Hand Mixers	2	Air Corn Popper	6
Iron	53	Security System	195
Hair Dryer	36	Perc Coffee	65
Toaster	39	Deep Fryer	20
Auto Coffee Maker	116	Waterbed Heaters	900
Blender	7	Humidifier	100
Heating Pads	3	Electric Toothbrush	20
Doorbell	18	Hot Oil Corn Popper	2
Answering Machine	29	Women's Shaver	12
Can Opener	3	Aquariums	548
Slow Cooker	16	Espresso Maker	19
Curling Iron	1	Electric Lawn Mower	100
Food Slicer	1	Mounted Air Cleaner	500
Garbage Disposer	10	Multi-fcn Device	41
Electric Knife	1	Electric Kettle	75
Portable Fans	8	Bottled Water Dispenser	300
Men's Shaver	13	Central Vacuum	24
Waffle Iron/Sandwich Grill	25	Grow Lights	800
Electric Blankets	120	Home Medical Equipment	400
Garage Door Opener	30		
Hair Setter	10		

A.3 Step 3: Determine Appliance Saturation, by Dwelling Type

Exhibit A 12 summarizes the saturation levels that are used in the present analysis. The assumed saturation levels are developed from the most recent REEUS. End uses fall into several categories:

- Some end uses are present in 100% of fully-occupied dwellings, including space heating,[35] ventilation and circulation, DHW, indoor and outdoor lighting, cooking, home entertainment electronics, and small appliance and other. These end uses are analyzed on the basis of UEC per dwelling, rather than UEC per appliance. Some of these end uses are not assumed to be present in all of the seasonal accounts, as the exhibit shows. Sentinel lighting, of course, includes only the outdoor lighting end use.
- Most of the remaining end uses are analyzed on the basis of UEC per appliance. Their saturation, as indicated in the table, reflects the average number of appliances per household. For example, the average household includes more than one refrigerator, and the saturation values in the exhibit reflect that.

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[35] Note that saturation of space heating, DHW, and cooking do not reflect how many households use electricity for those purposes. Electric share is discussed in the next section.

Exhibit A 12 Appliance Saturation Levels, (%)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	100%	100%	100%	100%	100%	100%	100%	135%	118%	86%
Pre-1980 non-electrically heated single detached homes	100%	100%	100%	100%	100%	100%	100%	123%	107%	79%
1980 & newer electrically heated single detached homes	100%	100%	100%	100%	100%	100%	100%	123%	107%	79%
Pre-1980 electrically heated single detached homes	100%	100%	100%	100%	100%	100%	100%	112%	98%	72%
1980 & newer non-electrically heated attached/row housing	100%	100%	100%	100%	100%	100%	100%	129%	112%	82%
Pre-1980 non-electrically heated attached/row housing	100%	100%	100%	100%	100%	100%	100%	114%	99%	73%
1980 & newer electrically heated attached/row housing	100%	100%	100%	100%	100%	100%	100%	117%	102%	75%
Pre-1980 electrically heated attached/row housing	100%	100%	100%	100%	100%	100%	100%	104%	90%	66%
Non-electrically heated apartment units	100%	100%	80%	100%	100%	100%	100%	100%	87%	64%
Non-electrically heated apartment common areas	100%	100%	20%	100%	100%	100%	0%	0%	0%	0%
Electrically heated apartment units	100%	100%	100%	100%	100%	100%	100%	100%	87%	64%
Electrically heated apartment common areas	100%	100%	0%	100%	100%	100%	0%	0%	0%	0%
Non-electrically heated mobile/other	100%	100%	100%	100%	100%	100%	100%	100%	87%	64%
Electrically heated mobile/other	100%	100%	100%	100%	100%	100%	100%	100%	87%	64%
Small diesel grid housing	100%	100%	100%	100%	100%	100%	100%	112%	98%	72%
Seasonal housing	50%	50%	50%	100%	100%	20%	50%	50%	44%	32%
Residential garages	100%	100%	0%	100%	100%	100%	0%	0%	0%	0%
Sentinell Lighting	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other
1980 & newer non-electrically heated single detached homes	124%	114%	13%	260%	232%	116%	100%	109%	28%	100%
Pre-1980 non-electrically heated single detached homes	113%	104%	12%	237%	211%	105%	100%	100%	25%	100%
1980 & newer electrically heated single detached homes	113%	103%	12%	237%	211%	105%	100%	100%	25%	100%
Pre-1980 electrically heated single detached homes	103%	94%	11%	216%	192%	96%	100%	91%	23%	100%
1980 & newer non-electrically heated attached/row housing	118%	108%	13%	248%	221%	110%	100%	104%	26%	100%
Pre-1980 non-electrically heated attached/row housing	104%	96%	11%	219%	195%	97%	100%	92%	23%	100%
1980 & newer electrically heated attached/row housing	107%	98%	11%	225%	201%	100%	100%	95%	24%	100%
Pre-1980 electrically heated attached/row housing	95%	87%	10%	200%	178%	89%	100%	84%	21%	100%
Non-electrically heated apartment units	46%	42%	0%	193%	172%	86%	100%	0%	0%	100%
Non-electrically heated apartment common areas	46%	42%	10%	0%	0%	0%	100%	81%	20%	100%
Electrically heated apartment units	46%	42%	0%	193%	172%	86%	100%	0%	0%	100%
Electrically heated apartment common areas	46%	42%	10%	0%	0%	0%	100%	81%	20%	100%
Non-electrically heated mobile/other	92%	84%	5%	193%	172%	86%	100%	81%	20%	100%
Electrically heated mobile/other	92%	84%	5%	193%	172%	86%	100%	81%	20%	100%
Small diesel grid housing	103%	94%	11%	216%	192%	96%	100%	91%	23%	100%
Seasonal housing	46%	42%	5%	96%	86%	43%	100%	0%	0%	100%
Residential garages	0%	0%	0%	0%	0%	0%	100%	91%	23%	100%
Sentinell Lighting	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

A.4 Step 4: Determine Fuel Share, by End Use and Dwelling Type

Data on fuel shares, for all end uses except space heating and DHW, is taken from the most recent Yukon REEUS. In the case of space heating, the starting point was the distribution of space heating appliances, by fuel type, as reported in the surveys and in the REEUS and the EnerGuide for Houses database, but the actual fuel share includes not only the presence of different appliances but also how much they are used. In particular it is affected by supplementary heating appliances, such as:

- Electric space heaters in non-electrically heated dwellings
- Non-electric sources (e.g., wood stoves) in electrically heated dwellings.

The space heating fuel shares presented in the exhibit[36] have been selected on the basis that they provide a reasonable fit with:

- General market description (i.e., known distribution of heating appliances by fuel)
- Electricity sales to different categories of homes.

Exhibit A 13 summarizes the electricity fuel shares assumed for each of the end uses included in the present analysis.

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[36] Adjustment of fuel shares for space heating was done in tandem with the adjustment of space heating loads described in Section 3.4 above.

Exhibit A 13 Electricity Fuel Shares, (%)

Dwelling Types	Space heating	Domestic hot water (DHW)	Cooking appliances	Clothes dryer	Spa heaters and pumps
1980 & newer non-electrically heated single detached homes	5%	79%	91%	97%	89%
Pre-1980 non-electrically heated single detached homes	5%	79%	91%	97%	89%
1980 & newer electrically heated single detached homes	89%	100%	100%	100%	100%
Pre-1980 electrically heated single detached homes	89%	100%	100%	100%	100%
1980 & newer non-electrically heated attached/row housing	5%	79%	91%	97%	89%
Pre-1980 non-electrically heated attached/row housing	5%	79%	91%	97%	89%
1980 & newer electrically heated attached/row housing	89%	100%	100%	100%	100%
Pre-1980 electrically heated attached/row housing	89%	100%	100%	100%	100%
Non-electrically heated apartment units	5%	100%	91%	97%	100%
Non-electrically heated apartment common areas	5%	0%	100%	97%	89%
Electrically heated apartment units	95%	100%	100%	100%	100%
Electrically heated apartment common areas	95%	100%	100%	100%	100%
Non-electrically heated mobile/other	5%	79%	92%	97%	91%
Electrically heated mobile/other	89%	100%	100%	100%	100%
Small diesel grid housing	4%	83%	92%	97%	91%
Seasonal housing	5%	83%	92%	97%	91%
Residential garages	5%	100%	100%	100%	100%

A.5 Step 5: Calibrate to sales data for the study Base Year of 2010

YEC and YECL provided electricity sales data for the year 2010, which was the latest year for which a complete year of data was available at the time of the study. Electricity sales were divided among the dwelling types and vintages according to the best information available from the utilities customer databases and from Marbek's energy end-use modelling. The RSEEM model was populated with data for UEC, saturation and electricity share and calibrated for a close match to the 2010 sales data.

A.6 Results by Supply System

This section of the appendix presents the base year electricity consumption for the hydro grid, large diesel, small diesel, and Old Crow supply systems. For each supply system, versions of Exhibit 6 and Exhibit 7 (which appear in Section 3 of the main body of the report) are provided below. The underlying assumptions such as unit energy consumption, saturation and electricity share are not presented by supply system. In general, the sample sizes for the diesel supply systems are too small to develop these detailed assumptions for the houses there. Instead, the end use consumptions are scaled to calibrate the model to the sales of electricity in those regions.

This section also does not replicate the pie charts and other graphs presented in Section 3. If those graphs are needed for each supply system, they can be created using the Data Manager.

Exhibit A 14 Average Electricity Use per Dwelling Unit, Hydro Grid Accounts (kWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	1,027	602	2,742	1,029	288	28	651	862	543	100
Pre-1980 non-electrically heated single detached homes	1,438	610	2,742	1,029	288	28	651	785	495	91
1980 & newer electrically heated single detached homes	12,075	100	3,453	1,029	288	28	716	784	494	91
Pre-1980 electrically heated single detached homes	14,856	100	3,453	1,029	288	28	716	715	450	83
1980 & newer non-electrically heated attached/row housing	656	463	2,164	698	189	14	434	669	422	63
Pre-1980 non-electrically heated attached/row housing	899	469	2,164	698	189	14	434	592	373	56
1980 & newer electrically heated attached/row housing	6,602	100	2,724	698	189	14	478	609	384	58
Pre-1980 electrically heated attached/row housing	9,045	100	2,724	698	189	14	478	539	340	51
Non-electrically heated apartment units	519	359	1,186	499	54	6	374	526	332	42
Non-electrically heated apartment common areas	1,265	4,385	-	6,101	660	72	-	-	-	-
Electrically heated apartment units	5,719	50	1,483	499	54	6	411	526	332	42
Electrically heated apartment common areas	13,935	611	-	6,101	660	72	-	-	-	-
Non-electrically heated mobile/other	851	469	2,164	698	189	14	441	521	328	49
Electrically heated mobile/other	9,345	100	2,724	698	189	14	478	521	328	49
Seasonal housing	35	15	241	174	49	-	56	54	34	6
Residential garages	500	366	-	617	173	-	-	-	-	-
Sentinel Lighting	-	-	-	-	645	-	-	-	-	-
Weighted Average	1,791	394	1,806	746	222	16	420	525	331	57

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total
1980 & newer non-electrically heated single detached homes	81	1,091	1,466	1,025	412	260	106	282	71	186	12,851
Pre-1980 non-electrically heated single detached homes	74	995	1,336	934	376	237	106	257	65	186	12,721
1980 & newer electrically heated single detached homes	73	1,024	1,505	933	375	237	106	257	65	186	23,819
Pre-1980 electrically heated single detached homes	67	934	1,372	850	342	216	106	234	59	186	26,083
1980 & newer non-electrically heated attached/row housing	51	692	1,395	975	392	248	72	269	68	126	10,060
Pre-1980 non-electrically heated attached/row housing	45	613	1,235	863	347	219	72	238	60	126	9,706
1980 & newer electrically heated attached/row housing	47	650	1,432	888	357	226	72	244	62	126	15,959
Pre-1980 electrically heated attached/row housing	41	575	1,267	786	316	200	72	216	54	126	17,832
Non-electrically heated apartment units	17	232	-	758	305	193	61	-	-	107	5,571
Non-electrically heated apartment common areas	209	2,833	2,179	-	-	-	-	2,553	643	-	20,900
Electrically heated apartment units	17	239	-	758	305	193	61	-	-	107	10,803
Electrically heated apartment common areas	209	2,917	2,447	-	-	-	-	2,553	643	-	30,149
Non-electrically heated mobile/other	40	541	554	758	305	193	72	209	53	126	8,574
Electrically heated mobile/other	40	555	612	758	305	193	72	209	53	126	17,368
Seasonal housing	5	69	277	64	26	16	18	-	-	31	1,170
Residential garages	-	-	-	-	-	-	-	234	59	1,200	3,149
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	645
Weighted Average	47	638	870	658	285	167	69	189	48	144	9,401

Exhibit A 15 Average Electricity Use per Dwelling Unit, Large Diesel Accounts (kWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	1,391	582	2,742	1,029	288	28	651	862	543	100
Pre-1980 non-electrically heated single detached homes	1,947	590	2,742	1,029	288	28	651	785	495	91
1980 & newer non-electrically heated attached/row housing	888	448	2,164	698	189	14	434	669	422	63
Pre-1980 non-electrically heated attached/row housing	1,217	454	2,164	698	189	14	434	592	373	56
Non-electrically heated apartment units	427	295	1,008	424	46	5	318	448	282	36
Non-electrically heated apartment common areas	1,464	3,605	-	4,332	469	51	-	-	-	-
Non-electrically heated mobile/other	1,258	693	2,315	747	202	15	472	557	351	53
Seasonal housing	37	14	253	183	51	-	59	57	36	7
Residential garages	355	354	-	438	122	-	-	-	-	-
Sentinel Lighting	-	-	-	-	645	-	-	-	-	-
Weighted Average	943	388	1,657	650	242	15	385	488	307	54

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total
1980 & newer non-electrically heated single detached homes	81	1,091	1,466	1,025	412	260	106	282	71	186	13,195
Pre-1980 non-electrically heated single detached homes	74	995	1,336	934	376	237	106	257	65	186	13,210
1980 & newer non-electrically heated attached/row housing	51	692	1,395	975	392	248	72	269	68	126	10,277
Pre-1980 non-electrically heated attached/row housing	45	613	1,235	863	347	219	72	238	60	126	10,009
Non-electrically heated apartment units	15	197	-	645	259	164	52	-	-	91	4,711
Non-electrically heated apartment common areas	149	2,011	1,547	-	-	-	-	1,813	456	-	15,897
Non-electrically heated mobile/other	43	579	593	812	326	206	77	223	56	135	9,713
Seasonal housing	5	72	291	67	27	17	19	-	-	33	1,227
Residential garages	-	-	-	-	-	-	-	166	42	852	2,330
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	645
Weighted Average	43	584	818	611	246	155	65	164	41	131	7,987

Exhibit A 16 Average Electricity Use per Dwelling Unit, Small Diesel Accounts (kWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
Small diesel grid housing	647	424	2,627	947	265	26	609	658	414	76
Seasonal housing	11	11	235	170	47	-	55	53	33	6
Residential garages	160	199	-	227	63	-	-	-	-	-
Sentinel Lighting	-	-	-	-	619	-	-	-	-	-
Grand Total	308	205	1,285	488	304	12	298	320	202	37

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total
Small diesel grid housing	62	837	1,143	782	315	199	97	215	54	171	10,567
Seasonal housing	5	67	270	63	25	16	17	-	-	31	1,114
Residential garages	-	-	-	-	-	-	-	86	22	442	1,200
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	619
Grand Total	30	408	600	381	153	97	50	102	26	96	5,401

Exhibit A 17 Average Electricity Use per Dwelling Unit, Old Crow Accounts (kWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
Small diesel grid housing	717	470	2,912	1,050	293	29	675	729	459	85
Seasonal housing	12	11	251	181	51	-	58	56	35	6
Sentinel Lighting	-	-	-	-	477	-	-	-	-	-
Grand Total	388	256	1,666	641	186	15	386	414	261	48

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total
Small diesel grid housing	68	928	1,267	867	349	220	108	239	60	190	11,715
Seasonal housing	5	71	288	67	27	17	19	-	-	33	1,188
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	477
Grand Total	39	527	806	492	196	125	66	127	32	116	6,788

Exhibit A 18 Electricity Consumption by End Use and Dwelling Type in the Base Year (2010), Hydro Grid Accounts (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	3,302	1,934	8,817	3,309	925	90	2,093	2,771	1,745	321
Pre-1980 non-electrically heated single detached homes	3,915	1,660	7,467	2,802	783	76	1,772	2,139	1,347	248
1980 & newer electrically heated single detached homes	6,267	52	1,792	534	149	15	372	407	256	47
Pre-1980 electrically heated single detached homes	6,522	44	1,516	452	126	12	315	314	198	36
1980 & newer non-electrically heated attached/row housing	279	197	921	297	80	6	185	285	180	27
Pre-1980 non-electrically heated attached/row housing	323	169	779	251	68	5	156	213	134	20
1980 & newer electrically heated attached/row housing	456	7	188	48	13	1	33	42	26	4
Pre-1980 electrically heated attached/row housing	534	6	161	41	11	1	28	32	20	3
Non-electrically heated apartment units	691	478	1,580	665	72	8	499	701	442	56
Non-electrically heated apartment common areas	186	644	-	896	97	11	-	-	-	-
Electrically heated apartment units	1,230	11	319	107	12	1	88	113	71	9
Electrically heated apartment common areas	334	15	-	146	16	2	-	-	-	-
Non-electrically heated mobile/other	684	377	1,740	561	152	11	355	419	264	40
Electrically heated mobile/other	1,205	13	351	90	24	2	62	67	42	6
Seasonal housing	109	46	744	536	150	-	172	166	105	19
Residential garages	132	96	-	163	45	-	-	-	-	-
Sentinel Lighting	-	-	-	-	515	-	-	-	-	-
Grand Total	26,170	5,749	26,375	10,900	3,239	241	6,129	7,669	4,829	838

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
1980 & newer non-electrically heated single detached homes	260	3,510	4,715	3,296	1,326	837	339	907	228	599	41,323	30%
Pre-1980 non-electrically heated single detached homes	200	2,709	3,640	2,544	1,023	646	287	700	176	507	34,644	25%
1980 & newer electrically heated single detached homes	38	532	781	484	195	123	55	133	34	97	12,362	9%
Pre-1980 electrically heated single detached homes	29	410	602	373	150	95	46	103	26	82	11,450	8%
1980 & newer non-electrically heated attached/row housing	22	295	594	415	167	106	30	114	29	54	4,284	3%
Pre-1980 non-electrically heated attached/row housing	16	221	445	311	125	79	26	86	22	45	3,494	3%
1980 & newer electrically heated attached/row housing	3	45	99	61	25	16	5	17	4	9	1,101	1%
Pre-1980 electrically heated attached/row housing	2	34	75	46	19	12	4	13	3	7	1,052	1%
Non-electrically heated apartment units	23	309	-	1,010	406	257	81	-	-	143	7,421	5%
Non-electrically heated apartment common areas	31	416	320	-	-	-	-	375	94	-	3,069	2%
Electrically heated apartment units	4	51	-	163	66	41	13	-	-	23	2,323	2%
Electrically heated apartment common areas	5	70	59	-	-	-	-	61	15	-	724	0.5%
Non-electrically heated mobile/other	32	435	446	610	245	155	58	168	42	102	6,896	5%
Electrically heated mobile/other	5	72	79	98	39	25	9	27	7	16	2,241	2%
Seasonal housing	16	212	855	198	80	50	55	-	-	97	3,610	3%
Residential garages	-	-	-	-	-	-	-	62	16	316	830	1%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	515	0.4%
Grand Total	686	9,319	12,708	9,610	3,866	2,441	1,009	2,766	696	2,097	137,337	100%

Exhibit A 19 Electricity Consumption by End Use and Dwelling Type in the Base Year (2010), Large Diesel Accounts (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	264	110	520	195	55	5	123	163	103	19
Pre-1980 non-electrically heated single detached homes	313	95	440	165	46	4	105	126	79	15
1980 & newer non-electrically heated attached/row housing	22	11	54	18	5	0	11	17	11	2
Pre-1980 non-electrically heated attached/row housing	26	10	46	15	4	0	9	13	8	1
Non-electrically heated apartment units	19	13	44	18	2	0	14	20	12	2
Non-electrically heated apartment common areas	4	10	-	12	1	0	-	-	-	-
Non-electrically heated mobile/other	100	55	184	59	16	1	37	44	28	4
Seasonal housing	7	3	46	33	9	-	11	10	6	1
Residential garages	6	6	-	7	2	-	-	-	-	-
Sentinel Lighting	-	-	-	-	55	-	-	-	-	-
Grand Total	760	313	1,335	523	195	12	310	393	248	43

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
1980 & newer non-electrically heated single detached homes	15	207	278	194	78	49	20	54	13	35	2,503	39%
Pre-1980 non-electrically heated single detached homes	12	160	215	150	60	38	17	41	10	30	2,122	33%
1980 & newer non-electrically heated attached/row housing	1	17	35	25	10	6	2	7	2	3	258	4%
Pre-1980 non-electrically heated attached/row housing	1	13	26	18	7	5	2	5	1	3	213	3%
Non-electrically heated apartment units	1	9	-	28	11	7	2	-	-	4	205	3%
Non-electrically heated apartment common areas	0	6	4	-	-	-	-	5	1	-	45	1%
Non-electrically heated mobile/other	3	46	47	64	26	16	6	18	4	11	771	12%
Seasonal housing	1	13	53	12	5	3	3	-	-	6	223	3%
Residential garages	-	-	-	-	-	-	-	3	1	14	38	1%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	55	1%
Grand Total	35	471	659	492	198	125	52	132	33	106	6,434	100%

Exhibit A 20 Electricity Consumption by End Use and Dwelling Type in the Base Year (2010), Small Diesel Accounts (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
Small diesel grid housing	69	45	282	102	28	3	65	71	44	8
Seasonal housing	1	1	13	9	3	-	3	3	2	0
Residential garages	1	1	-	1	0	-	-	-	-	-
Sentinel Lighting	-	-	-	-	38	-	-	-	-	-
Grand Total	71	47	295	112	70	3	68	73	46	9

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
Small diesel grid housing	7	90	123	84	34	21	10	23	6	18	1,133	91%
Seasonal housing	0	4	15	4	1	1	1	-	-	2	62	5%
Residential garages	-	-	-	-	-	-	-	0	0	2	5	0%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	38	3%
Grand Total	7	94	138	87	35	22	11	23	6	22	1,239	100%

Exhibit A 21 Electricity Consumption by End Use and Dwelling Type in the Base Year (2010), Old Crow Accounts (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
Small diesel grid housing	55	36	223	80	22	2	52	56	35	6
Seasonal housing	1	1	16	12	3	-	4	4	2	0
Sentinel Lighting	-	-	-	-	1	-	-	-	-	-
Grand Total	56	37	239	92	27	2	56	59	37	7

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
Small diesel grid housing	5	71	97	66	27	17	8	18	5	15	895	92%
Seasonal housing	0	5	19	4	2	1	1	-	-	2	77	8%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	1	0%
Grand Total	6	76	116	71	28	18	9	18	5	17	973	100%

Appendix B Background-Section 4: Base Year Peak Load

Introduction

Appendix B provides additional detailed information related to each of the major steps employed in the generation of the Residential sector Base Year peak loads. The discussion is organized as follows:

- Overview of peak load methodology
- Segmentation of residential dwellings
- Detailed results.

B.1 Overview of Peak Load Profile Methodology

As noted in the main text, development of the electric peak load estimates employs four specific factors as outlined below:

- **Monthly Usage Allocation Factor:** This factor represents the percent of annual electric energy usage that is allocated to each month. This set of monthly fractions (percentages) reflects the seasonality of the load shape, whether a facility, process or end use, and is dictated by weather or other seasonal factors. This allocation factor can be obtained from either (in decreasing order of priority): (a) monthly consumption statistics from end-use load studies; (b) monthly seasonal sales (preferably weather normalized) obtained by subtracting a "base" month from winter and summer heating and cooling months; or (c) heating or cooling degree days on an appropriate base.
- **Weekend to Weekday Factor:** This factor is a ratio that describes the relationship between weekends and weekdays, reflecting the degree of weekend activity inherent in the facility or end use. This may vary by month or season. Based on this ratio, the average electric energy per day type can be computed from the corresponding monthly electric energy.
- **Peak Day Factor:** This factor reflects the degree of daily weather sensitivity associated with the load shape, particularly heating or cooling; it compares a peak (e.g., hottest or coldest) day to a typical weekday in that month.
- **Per Unit Hourly Factor:** The relationship of load among different hours of the day for each day type (weekday, weekend day, peak day) and for each month reflects the operating hours of the electric equipment or end use within residences by sub sector. For example, for lighting, this would be affected by time of day, season (affected by daylight), and room type, where applicable. For the Base Year, lighting is treated on an aggregate basis by total residence.

The four factors (sets of ratios) defined above provide the basis for converting annual energy to any hourly demand specified including the grouping of hours used in the four peak periods defined in this study. Exhibit B 1, below, illustrates how each of the above four factors is applied sequentially to a known annual energy value to produce a peak load value, defined as a specific peak period. In the example, the Annual Peak Hour is used.

Exhibit B 1 Illustrative Application of Annual Energy to Peak Period Value Factors

The Annual Peak Hour demand is computed based on the December peak day at 6 pm. The Yukon peak is assumed to occur in December, although the model allows for a January peak, as well.

The following steps are required:

- Step 1: The monthly usage allocation factor for December is applied to the annual energy use to calculate December energy use.
- Step 2: The average weekday in December is calculated based on the formula shown below, which adjusts the average day type use to reflect any difference in typical weekend use versus typical weekday use.
  1/[Days in Month * (5/7 + 2/7 * Weekend Ratio)]
- Step 3: The peak day factor is then applied to the average weekday electric energy use to determine the peak day use (as defined by the Yukon utilities).
- Step 4: The peak hour is then calculated based on allocating the peak day use according to the per unit hourly load factor for a peak winter (December) day, using the percentage of use in that hour versus the daily usage for the December peak day.

It should be noted that the methodology shown in Exhibit B 1 produces aggregate diversified average loads for all customers or end uses in the defined sub sector.

Exhibit B 2 provides a specific numeric example for the calculation of Annual Peak Hour demand (kW). The example presented in Exhibit B 2 is for DHW use in pre-1980 single detached homes, prior to adjustment for fuel share. The example shows how the annual consumption of 2,989 kWh can be converted to a peak demand value for the Annual Peak Hour by the calculation of a corresponding hours-use value.

Exhibit B 2 Sample Hours-Use Calculation for Electric Water Heating

Annual Peak Hour: 6 pm Winter Peak
Annual kWh * Mo. Allocation * 1/(Days in Month * (5/7 + 2/7 * Weekend Ratio)) * Peak Day Factor * Peak Hour % Daily kWh
7 pm Winter Peak = 2,989 [Annual kWh] * 8.72% [Mo. Allocation] * 1/(31 * (5/7 + 2/7 * 1.0 [Dec. Weekend Ratio Calc])) * 1.0 [Dec. Peak Day Factor] * 0.035022 [Peak Hour % Day kWh] = 0.294 kW
Hours-Use Factor = 2,989 [annual kWh] / 0.294 [7 pm Winter Peak] = 10,153 [Annual Peak Hour Hours Use]
This means that any applicable single-family detached annual water heating kWh can be converted to demand at winter peak hour (6 pm) by dividing by 10,153.

For other peak periods, different sets of hours are used, with calculations corresponding to the above steps. The resulting relationship between annual use and peak can be defined in terms of an hours-use factor, the ratio of the annual energy to the peak, for each of the four defined peak periods.

B.2 Segmentation of Residential Dwellings

The Residential sector segmentation used to generate the electric peak load profiles is the same as that used for electric energy use. That is, there is a load profile that corresponds to each combination of dwelling type and end use.

Exhibit B 3 shows the residential dwelling types that were addressed.

Exhibit B 3 Residential Dwelling Types Used for Electric Peak Load Calculations

Dwelling Type (SDH/ Duplex, Farm House, First Nations, Row house, Condo low vs. high-rise, Mobile/Other)
Building Vintage (Pre- vs. Post-1980)
Heating Fuel (Electric vs. Non-electric)

Exhibit B 4 describes the assumptions and data sources for each of the four load profile factors that were used to develop the corresponding hours-use factors. To produce a demand for a combination of sub sector and end use, the corresponding annual energy is divided by the hours-use factor for each of the four peak periods for the applicable load shape. For certain end uses that are assumed to have no usage during the winter months (e.g., cooling) the hours-use values are considered infinite (noted by 1E+15), resulting in virtually zero demand when divided into annual energy.

Exhibit B 4 Residential End Use Load Shape Parameters

Load Shape #	End Use	Monthly Breakdown	Wkend / Wkday Ratio	Peak Day Factor	Hourly Profile
1001	Space Heating – Detached/Duplex, First Nations	10-yr average Whitehorse HDD	1.09 BC Hydro Res. Load Model - SDH[37]	10-yr average Whitehorse HDD	BCH Residential Premise Load Model - SDH
1002	Space Heating – Row Houses	10-yr average Whitehorse HDD	BC Hydro Res. Load Model - Row[38]	10-yr average Whitehorse HDD	BCH Residential Premise Load Model - Row
1003	Central A/C – All	10-yr average Whitehorse CDD	1.00 various studies	10-yr average Whitehorse CDD Ratio	RG&E 1991 Study
1004	Water Heating – All	RG&E 1991 Study	1.00 various studies	1.0 Assumed	RG&E 1991 Study
1005	Cooking – All	Mass. JUMP	Mass JUMP[39, 40]	1.0 Assumed	Mass. JUMP
1006	Refrigerator – All	Mass. JUMP	1.00 various studies	1.0 Assumed	Mass. JUMP
1007	Lighting – All	LILCO Direct Install Program 1991 adj. by DOE[41] Seasonality	LILCO[42]	1.0 Assumed	LILCO Direct Install Program 1991 adj. by DOE Seasonality
1008	Clothes Dryer – All	Mass. JUMP Refrigerator	Mass. JUMP	1.0 Assumed	Mass. JUMP
1009	Clothes Washer – All	LILCO DSM			
1010	Dishwasher – All	LILCO DSM Program Eval 1988-1991	1.00 various studies	1.0 Assumed	ELCAP DOE[43]
1011	General Plug Loads	USDOE Building America 2008 Misc. Electric Loads[6]	1.00 Assumed	1.0 Assumed	USDOE Building America 2008 Misc. Electric Load
1012	Television – All	California Energy Commission			
1013	Room A/C – All	10-yr average Whitehorse CDD	1.00 various studies	10-yr average Whitehorse CDD Ratio	RG&E 1991 Study
1014	Pool Pumps, Hot Tubs	BCH REUS[44] & SCE RAEUS[45]	SCE RAEUS	SCE RAEUS	Hr End 7pm SCE RAEUS

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[37] BC Hydro FY 2005 (April 2004 – March 2005) Residential Load Research data by segment (SDH – Single Family; Row – Row Houses).

[38] BC Hydro FY 2005 (April 2004 – March 2005) Residential Load Research data by segment (SDH – Single Family; Row – Row Houses).

[39] Massachusetts JUMP Update and Analysis (Appliance Monitoring Project), AEIC Northeast Regional Conference and Proceedings; Hartford, CT; September 16, 1988; S. Chiara (ComEnergy) and J. Lopes (AEG).

[40] Massachusetts Joint Utility End Use Monitoring Project Final Report – Final Report; Applied Energy Group, Inc.; Feb 15, 1989.

[41] Building America Research Benchmark Definition – Updated December 20, 2007; USDOE Renewable Energy Laboratory NREL/TP-550-42662; January 2008.

[42] Long Island Lighting Company; DSM Program Evaluations; 1988 – 1991.

[43] Description of Electric Energy Use in Single-Family Residences in the Pacific Northwest (ELCAP), DOE/BP-13795-21, PNNL; ref. in "Building America Research Benchmark Definition"; Jan. 2008.

[44] BC Hydro REUS (Appliance Saturation Study) estimates of saturation of component appliances (outdoor and indoor pools, outdoor hot tubs and indoor Jacuzzis), and SCE RAEUS monthly energy use used to calculate weighted monthly energy use for monthly allocation averages.

Load Shape #	End Use	Monthly Breakdown	Wkend / Wkday Ratio	Peak Day Factor	Hourly Profile
1015	Engine Block Heater	10-yr average Whitehorse HDD < -10HDD	1.00 assumed	10-yr average Whitehorse HDD	Flat, average 7.9 hrs/day for 90 days[46]
1016	Ventilation – Total Commercial	RG&E Total Commercial Ventilation	RG&E Total Commercial Ventilation	RG&E Total Commercial Ventilation	RG&E Total Commercial Ventilation
1017	Outdoor Lighting	Dusk-to-Dawn Model, with Whitehorse sunrise/sunset	1.00 Assumed	1.0 Assumed	Based on Dusk-to-Dawn Model, Whitehorse sunrise/sunset[47]
1018	Holiday Lighting	90% December 10% January	1.00 Assumed	1.0 Assumed	Dusk to Midnight model, similar to base lighting until midnight only

Exhibit B 5 shows the distinct hour-use values developed for each combination of peak period, sector, sub sector and end use employed in this study, as generated from the applicable load shape.

The hours-use value represents the divisor to convert annual energy (e.g., MWH) to that peak period demand. For example, dividing the annual electricity consumed for space heating in single detached houses by the hours-use value for the Annual Peak Hour (i.e., 2,798) will convert annual MWh to demand at the annual system peak hour (6 pm).

Exhibit B 5 Residential Sector Load Shape Hours-Use Values

CODE	Sector Type	SubSector	Region	End Use	End Use Sub	Measure	Hours-use Values		
							Peak1 Annual Peak Hour	Peak2 Evening Peak	Peak3 Morning Peak
1001	Res	SDH	All	Space Heat	All	Base	2,798	2,865	4,130
1002	Res	Row	All	Space Heat	All	Base	2,818	2,850	4,830
1003	Res	All	All	Central A/C	All	Base	1.00E+15	1.00E+15	1.00E+15
1004	Res	All	All	Water Heat	All	Base	11,285	10,114	3,969
1005	Res	All	All	Stove	All	Base	1,479	3,196	4,796
1006	Res	All	All	Refrigerator	All	Base	7,949	8,374	10,525
1007	Res	All	All	Lighting	All	Base	4,137	3,724	9,325
1008	Res	All	All	Dryer	All	Base	3,687	4,519	28,385
1009	Res	All	All	Clothes Washer	All	Base	5,403	5,412	13,836
1010	Res	All	All	Dishwasher	All	Base	5,787	4,208	6,944
1011	Res	All	All	General Plug Loads	All	Base	6,759	6,609	9,012
1012	Res	All	All	Television	All	Base	6,393	6,473	8,764
1013	Res	All	All	Room A/C	All	Base	1.00E+15	1.00E+15	1.00E+15
1014	Res	All	All	Pools and Hot tubs	All	Base	6,542	6,953	7,053
1015	Res	All	All	Engine Block Heaters	All	Base	1,493	1,194	1.00E+15
1016	Res	All	All	Ventilation	All	Base	6,245	6,698	6,824
1017	Res	All	All	Outdoor Lighting	All	Base	4,277	4,602	4,103
1018	Res	All	All	Holiday Lighting	All	Base	271	260	1.00E+15

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[45] Southern California Edison 1988 RAEUS (End Use) Study – Indoor/outdoor Pool Pumps and Electric Spas/Jacuzzis.

[46] Ontario Power Authority – OPA Measures and Assumptions List (prescriptive) as of January 31, 2010; 1450 watts at 7.9 hours/day x 90 days.

[47] Based on Whitehorse sunrise/sunset times, with 5% during daylight hours.

Since YECL does not conduct regular class or end-use load analysis studies, there is no actual total (or dwelling type) end-use load profile upon which to calibrate the load profile models developed for this study. Class load studies have been performed for cost-of-service and rate design purposes, but results were not yet available. End-use data collection has not been performed. Summing all end uses would produce a total residential daily load profile, but the YECL class load profile to which it would be compared would still only be a statistical estimate and not an actual, in the same way that the annual kWh energy sales would be for the calibration of total annual kWh. The best option for calibrating Yukon-specific load profile parameters is the weather-sensitive loads, since that is the most area specific.

Since separately metered space heating end-use load data was not available from YECL, normal weather for the past 10 years was used to determine monthly allocations, and weekend/weekday ratios were developed from similar studies for another Canadian utility.

For peak day factors, analysis of the past 10 years' average vs. peak weather conditions (in heating degree days) for Whitehorse was analyzed to determine typical peak day factors for normal weather, which ranged from about 1.4 to 1.5 for winter months. For non weather-sensitive end uses, a factor of 1.0 was assumed, absent specific load study data.

B.3 Detailed Results

The next three exhibits show peak demand by dwelling type and end use for each of the three peak periods identified for this study. These first three exhibits are followed by twelve more showing the results by supply system.

Note that in each of the exhibits, the end uses are sorted from largest peak demand to smallest peak demand, so they do not appear in the same order in the three exhibits.

Exhibit B 6 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use (MW)*

Dwelling Type	Space heating	Cooking appliances	Indoor lighting	Clothes dryer	Domestic hot water (DHW)	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Refrigerator	Ventilation & circulation
Single Detached Houses	7.36	3.23	1.80	2.04	1.82	1.56	1.30	1.04	0.74	0.62
Apartments	0.87	0.41	0.45	0.23	0.17	0.06	0.30	0.18	0.10	0.19
Attached/Row Houses	0.58	0.29	0.16	0.17	0.19	0.19	0.16	0.13	0.08	0.06
Mobile/Other	0.71	0.31	0.17	0.15	0.20	0.09	0.14	0.11	0.07	0.07
Seasonal & Garage	0.09	0.13	0.18	0.06	0.07	0.14	0.04	0.03	0.02	0.02
Small Grid Housing	0.04	0.08	0.04	0.04	0.04	0.03	0.03	0.02	0.02	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	9.66	4.44	2.81	2.70	2.50	2.08	1.97	1.52	1.03	0.98

Dwelling Type	Holiday lighting	Outdoor lighting	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Single Detached Houses	0.75	0.49	0.47	0.44	0.33	0.28	0.20	0.12	0.12	0.10	24.82
Apartments	0.08	0.05	0.07	0.08	0.07	0.05	0.03	0.02	0.01	0.01	3.41
Attached/Row Houses	0.05	0.04	0.05	0.06	0.04	0.03	0.02	0.01	0.01	0.01	2.33
Mobile/Other	0.05	0.05	0.04	0.05	0.04	0.03	0.02	0.01	0.01	0.01	2.33
Seasonal & Garage	-	0.05	0.01	0.01	0.01	0.01	0.06	0.01	0.00	0.00	0.99
Small Grid Housing	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.44
Sentinel Lighting	-	0.14	-	-	-	-	-	-	-	-	0.14
Grand Total	0.95	0.83	0.65	0.65	0.50	0.41	0.33	0.17	0.15	0.14	34.46

*Results are measured at the customer's point-of-use and do not include line losses. Any differences in totals are due to rounding.

Exhibit B 7 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use (MW)

Dwelling Type	Space heating	Indoor lighting	Domestic hot water (DHW)	Block heaters & car warmers	Clothes dryer	Cooking appliances	Spa heaters and pumps	Computer and peripherals	Holiday lighting	Refrigerator
Single Detached Houses	7.18	2.00	2.03	1.62	1.67	1.50	1.47	1.07	0.78	0.71
Apartments	0.86	0.50	0.19	0.37	0.19	0.19	0.06	0.18	0.08	0.10
Attached/Row Houses	0.58	0.18	0.21	0.20	0.14	0.13	0.18	0.13	0.05	0.07
Mobile/Other	0.69	0.19	0.23	0.18	0.12	0.14	0.08	0.12	0.06	0.06
Seasonal & Garage	0.09	0.20	0.08	0.05	0.05	0.06	0.14	0.03	-	0.02
Small Grid Housing	0.04	0.05	0.05	0.03	0.04	0.04	0.03	0.02	0.02	0.02
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	9.45	3.12	2.79	2.46	2.20	2.05	1.96	1.55	0.99	0.98

Dwelling Type	Ventilation & circulation	Outdoor lighting	Television	Heat tape, propane htrs, circ pumps	Freezer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Single Detached Houses	0.58	0.45	0.44	0.41	0.45	0.28	0.20	0.16	0.12	0.10	23.22
Apartments	0.17	0.04	0.07	0.09	0.06	0.05	0.03	0.02	0.01	0.01	3.28
Attached/Row Houses	0.06	0.04	0.05	0.05	0.05	0.03	0.02	0.01	0.01	0.01	2.22
Mobile/Other	0.07	0.04	0.05	0.04	0.04	0.03	0.02	0.01	0.01	0.01	2.19
Seasonal & Garage	0.02	0.05	0.01	0.01	0.01	0.01	0.07	0.01	0.01	0.00	0.93
Small Grid Housing	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.41
Sentinel Lighting	-	0.13	-	-	-	-	-	-	-	-	0.13
Grand Total	0.92	0.77	0.64	0.62	0.62	0.40	0.34	0.21	0.17	0.14	32.38

Exhibit B 8 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use (MW)

Dwelling Type	Domestic hot water (DHW)	Space heating	Spa heaters and pumps	Cooking appliances	Indoor lighting	Computer and peripherals	Ventilation & circulation	Outdoor lighting	Refrigerator	Freezer
Single Detached Houses	5.18	4.98	1.45	1.00	0.80	0.78	0.57	0.51	0.56	0.35
Apartments	0.49	0.51	0.05	0.13	0.20	0.13	0.17	0.05	0.08	0.05
Mobile/Other	0.57	0.48	0.08	0.09	0.08	0.09	0.07	0.05	0.05	0.03
Attached/Row Houses	0.54	0.34	0.18	0.09	0.07	0.10	0.06	0.04	0.06	0.04
Seasonal & Garage	0.21	0.06	0.13	0.04	0.08	0.02	0.02	0.05	0.02	0.01
Small Grid Housing	0.13	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
Sentinel Lighting	-	-	-	-	-	-	-	0.15	-	-
Grand Total	7.12	6.41	1.93	1.37	1.25	1.14	0.90	0.86	0.78	0.49

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Holiday lighting	Grand Total
Single Detached Houses	0.32	0.27	0.20	0.15	0.10	0.09	0.04	0.00	0.00	0.00	17.35
Apartments	0.06	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	2.02
Mobile/Other	0.04	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.70
Attached/Row Houses	0.04	0.02	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.64
Seasonal & Garage	0.01	0.01	0.01	0.05	0.00	0.01	0.00	0.00	0.00	-	0.73
Small Grid Housing	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.15
Grand Total	0.47	0.35	0.30	0.25	0.13	0.12	0.05	0.00	0.00	0.00	23.91

Exhibit B 9 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use, Hydro Grid Accounts (MW)

Dwelling Type	Space heating	Cooking appliances	Indoor lighting	Clothes dryer	Domestic hot water (DHW)	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Refrigerator	Ventilation & circulation
Single Detached Houses	7.15	3.08	1.72	1.94	1.74	1.49	1.24	0.99	0.71	0.59
Apartments	0.87	0.40	0.44	0.23	0.17	0.06	0.29	0.17	0.10	0.18
Attached/Row Houses	0.57	0.27	0.15	0.16	0.18	0.19	0.15	0.12	0.07	0.06
Mobile/Other	0.68	0.28	0.16	0.14	0.19	0.08	0.13	0.10	0.06	0.06
Seasonal & Garage	0.09	0.12	0.17	0.06	0.07	0.13	0.04	0.03	0.02	0.02
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	9.34	4.14	2.63	2.53	2.34	1.94	1.85	1.42	0.96	0.92

Dwelling Type	Holiday lighting	Outdoor lighting	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Single Detached Houses	0.71	0.46	0.45	0.42	0.31	0.27	0.19	0.11	0.11	0.10	23.77
Apartments	0.08	0.05	0.06	0.07	0.07	0.05	0.02	0.01	0.01	0.01	3.36
Attached/Row Houses	0.05	0.04	0.05	0.05	0.04	0.03	0.02	0.01	0.01	0.01	2.23
Mobile/Other	0.05	0.04	0.04	0.04	0.03	0.03	0.02	0.01	0.01	0.01	2.15
Seasonal & Garage	-	0.05	0.01	0.01	0.01	0.01	0.06	0.01	0.00	0.00	0.91
Sentinel Lighting	-	0.12	-	-	-	-	-	-	-	-	0.12
Grand Total	0.89	0.76	0.61	0.60	0.47	0.38	0.31	0.16	0.14	0.13	32.54

Exhibit B 10 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use, Hydro Grid Accounts (MW)

Dwelling Type	Space heating	Indoor lighting	Domestic hot water (DHW)	Block heaters & car warmers	Clothes dryer	Cooking appliances	Spa heaters and pumps	Computer and peripherals	Holiday lighting	Refrigerator
Single Detached Houses	6.98	1.91	1.94	1.54	1.58	1.42	1.40	1.01	0.74	0.67
Apartments	0.86	0.49	0.19	0.37	0.19	0.18	0.05	0.18	0.08	0.10
Attached/Row Houses	0.56	0.17	0.20	0.19	0.13	0.13	0.17	0.13	0.05	0.07
Mobile/Other	0.66	0.17	0.21	0.16	0.11	0.13	0.08	0.11	0.05	0.06
Seasonal & Garage	0.08	0.19	0.07	0.05	0.05	0.05	0.12	0.03	-	0.02
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	9.14	2.93	2.61	2.32	2.06	1.92	1.83	1.45	0.92	0.92

Dwelling Type	Ventilation & circulation	Outdoor lighting	Television	Heat tape, propane htrs, circ pumps	Freezer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Single Detached Houses	0.55	0.43	0.42	0.39	0.42	0.26	0.19	0.16	0.11	0.10	22.24
Apartments	0.17	0.04	0.07	0.09	0.06	0.05	0.03	0.02	0.01	0.01	3.23
Attached/Row Houses	0.06	0.04	0.05	0.05	0.04	0.03	0.02	0.01	0.01	0.01	2.12
Mobile/Other	0.06	0.04	0.04	0.04	0.04	0.03	0.02	0.01	0.01	0.01	2.03
Seasonal & Garage	0.02	0.04	0.01	0.01	0.01	0.01	0.06	0.00	0.01	0.00	0.86
Sentinel Lighting	-	0.11	-	-	-	-	-	-	-	-	0.11
Grand Total	0.86	0.70	0.60	0.58	0.58	0.38	0.32	0.20	0.16	0.13	30.59

Exhibit B 11 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use, Hydro Grid Accounts (MW)

Dwelling Type	Domestic hot water (DHW)	Space heating	Spa heaters and pumps	Cooking appliances	Indoor lighting	Computer and peripherals	Ventilation & circulation	Outdoor lighting	Refrigerator	Freezer
Single Detached Houses	4.94	4.84	1.38	0.95	0.76	0.74	0.54	0.48	0.53	0.34
Apartments	0.48	0.51	0.05	0.12	0.19	0.13	0.17	0.05	0.08	0.05
Mobile/Other	0.53	0.46	0.07	0.09	0.07	0.08	0.06	0.04	0.05	0.03
Attached/Row Houses	0.52	0.33	0.17	0.08	0.07	0.09	0.06	0.04	0.05	0.03
Seasonal & Garage	0.19	0.06	0.12	0.04	0.07	0.02	0.02	0.05	0.02	0.01
Sentinel Lighting	-	-	-	-	-	-	-	0.13	-	-
Grand Total	6.65	6.19	1.80	1.28	1.17	1.07	0.84	0.79	0.73	0.46

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Holiday lighting	Grand Total
Single Detached Houses	0.31	0.25	0.19	0.14	0.09	0.08	0.04	0.00	0.00	0.00	16.62
Apartments	0.05	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	1.99
Mobile/Other	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.57
Attached/Row Houses	0.04	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.56
Seasonal & Garage	0.01	0.01	0.01	0.05	0.00	0.01	0.00	0.00	0.00	-	0.67
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.13
Grand Total	0.44	0.33	0.28	0.23	0.12	0.12	0.05	0.00	0.00	0.00	22.54

Exhibit B 12 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use, Large Diesel Accounts (MW)

Dwelling Type	Space heating	Cooking appliances	Clothes dryer	Indoor lighting	Domestic hot water (DHW)	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Ventilation & circulation	Refrigerator
Single Detached Houses	0.21	0.15	0.10	0.09	0.09	0.08	0.06	0.05	0.03	0.04
Mobile/Other	0.04	0.03	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01
Attached/Row Houses	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
Apartments	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Seasonal & Garage	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	0.27	0.21	0.13	0.13	0.12	0.10	0.09	0.07	0.05	0.05

Dwelling Type	Outdoor lighting	Holiday lighting	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Single Detached Houses	0.02	0.04	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	1.05
Mobile/Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
Attached/Row Houses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Apartments	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Seasonal & Garage	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Sentinel Lighting	0.01	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	1.45

Exhibit B 13 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use, Large Diesel Accounts (MW)

Dwelling Type	Space heating	Indoor lighting	Domestic hot water (DHW)	Block heaters & car warmers	Clothes dryer	Cooking appliances	Spa heaters and pumps	Computer and peripherals	Refrigerator	Ventilation & circulation
Single Detached Houses	**0.20**	**0.10**	**0.09**	**0.08**	**0.08**	**0.07**	**0.07**	**0.05**	**0.03**	**0.03**
Mobile/Other	**0.03**	**0.02**	**0.02**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
Attached/Row Houses	**0.02**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.00**	**0.00**
Apartments	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Seasonal & Garage	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	0.27	0.14	0.13	0.11	0.10	0.10	0.09	0.07	0.05	0.05

Dwelling Type	Holiday lighting	Outdoor lighting	Television	Freezer	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Single Detached Houses	**0.04**	**0.02**	**0.02**	**0.02**	**0.02**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.98**
Mobile/Other	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.16**
Attached/Row Houses	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.10**
Apartments	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**
Seasonal & Garage	-	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**
Sentinel Lighting	-	**0.01**	-	-	-	-	-	-	-	-	**0.01**
Grand Total	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.01	1.35

Exhibit B 14 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use, Large Diesel Accounts (MW)

Dwelling Type	Domestic hot water (DHW)	Space heating	Spa heaters and pumps	Cooking appliances	Indoor lighting	Computer and peripherals	Outdoor lighting	Ventilation & circulation	Refrigerator	Freezer
Single Detached Houses	0.24	0.14	0.07	0.05	0.04	0.04	0.02	0.03	0.03	0.02
Mobile/Other	0.05	0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00
Attached/Row Houses	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seasonal & Garage	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apartments	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sentinel Lighting	-	-	-	-	-	-	0.01	-	-	-
Grand Total	0.34	0.18	0.09	0.06	0.06	0.05	0.05	0.05	0.04	0.02

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Holiday lighting	Grand Total
Single Detached Houses	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.73
Mobile/Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13
Attached/Row Houses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.04
Apartments	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.02

Exhibit B 15 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use, Small Diesel Accounts (MW)

Dwelling Type	Cooking appliances	Indoor lighting	Domestic hot water (DHW)	Clothes dryer	Space heating	Spa heaters and pumps	Outdoor lighting	Block heaters & car warmers	Computer and peripherals	Holiday lighting
Small Grid Housing	0.04	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
Sentinel Lighting	-	-	-	-	-	-	0.01	-	-	-
Grand Total	0.05	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01

Dwelling Type	Refrigerator	Ventilation & circulation	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Small Grid Housing	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.25
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.27

Exhibit B 16 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use, Small Diesel Accounts (MW)

Dwelling Type	Indoor lighting	Domestic hot water (DHW)	Space heating	Cooking appliances	Clothes dryer	Spa heaters and pumps	Block heaters & car warmers	Outdoor lighting	Computer and peripherals	Holiday lighting
Small Grid Housing	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
Sentinel Lighting	-	-	-	-	-	-	-	0.01	-	-
Grand Total	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01

Dwelling Type	Refrigerator	Ventilation & circulation	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Small Grid Housing	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.23
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.25

Exhibit B 17 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use, Small Diesel Accounts (MW)

Dwelling Type	Domestic hot water (DHW)	Spa heaters and pumps	Space heating	Outdoor lighting	Cooking appliances	Indoor lighting	Computer and peripherals	Refrigerator	Ventilation & circulation	Freezer
Small Grid Housing	0.07	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sentinel Lighting	-	-	-	0.01	-	-	-	-	-	-
Grand Total	0.07	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Holiday lighting	Grand Total
Small Grid Housing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20

Exhibit B 18 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use, Old Crow Accounts (MW)

Dwelling Type	Cooking appliances	Indoor lighting	Domestic hot water (DHW)	Clothes dryer	Space heating	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Holiday lighting	Refrigerator
Small Grid Housing	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	-	0.00
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	0.04	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01

Dwelling Type	Outdoor lighting	Ventilation & circulation	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Small Grid Housing	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20
Seasonal & Garage	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.01
Sentinel Lighting	0.00	-	-	-	-	-	-	-	-	-	0.00
Grand Total	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21

Exhibit B 19 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use, Old Crow Accounts (MW)

Dwelling Type	Indoor lighting	Domestic hot water (DHW)	Space heating	Cooking appliances	Clothes dryer	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Holiday lighting	Refrigerator
Small Grid Housing	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.01
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	-	0.00
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01

Dwelling Type	Outdoor lighting	Ventilation & circulation	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Small Grid Housing	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18
Seasonal & Garage	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.01
Sentinel Lighting	0.00	-	-	-	-	-	-	-	-	-	0.00
Grand Total	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19

Exhibit B 20 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use, Old Crow Accounts (MW)

Dwelling Type	Domestic hot water (DHW)	Spa heaters and pumps	Space heating	Cooking appliances	Indoor lighting	Computer and peripherals	Outdoor lighting	Refrigerator	Ventilation & circulation	Freezer
Small Grid Housing	0.06	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sentinel Lighting	-	-	-	-	-	-	0.00	-	-	-
Grand Total	0.06	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Holiday lighting	Grand Total
Small Grid Housing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.00
Grand Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15

Appendix C Background-Section 5: Reference Case Electricity Use

Introduction

Appendix C provides additional detailed information related to each of the major steps employed to generate the profile of Residential sector Reference Case electricity use. The major steps involved are:

- Step 1: Estimate net space heating and cooling loads for each new dwelling type
- Step 2: Estimate naturally-occurring changes in net space heating and cooling loads for existing dwelling types
- Step 3: Estimate naturally-occurring changes in annual electricity use for the evolving stock of major residential appliances
- Step 4: Estimate future appliance saturation trends for each dwelling type
- Step 5: Estimate changes in electricity share for each appliance, by dwelling type
- Step 6: Estimate the growth in number of residential dwellings, by type.

C.1 Step 1: Estimation of Net Space Heating and Cooling Loads—New Dwellings

The first task in building the Reference Case involved the development of estimates of the net space heating loads for new dwellings to be built over the study period. As was the case with the existing building stock, the study relied on several sources to prepare these estimates, including:

- Estimated electricity consumption per dwelling from the Yukon load forecast
- Consultation with housing experts at Yukon Housing Corporation
- Review of experience in other jurisdictions.

Based on consideration of the best available data from the above sources, this study assumes that the net space heating loads in new dwellings are likely to decrease slightly compared to existing dwellings. This conclusion recognizes that while thermal efficiencies are improving in new dwellings, they are being partially offset by changing construction practices.

Examples of these offsetting trends include:

- Overall, window, wall and roofing thermal efficiency levels have increased in new residential buildings and air leakage rates have been reduced by more than 40% compared to typical existing dwellings
- The amount of window area in new houses has increased by up to 20% compared to typical existing homes
- The new stock tends to have floor areas that are slightly larger, on average, than existing dwellings, though this trend has levelled off recently
- Buildings also feature an increase in exterior wall surface area of between 5%-20%. This reflects both the increased floor area and a tendency for homes to include architectural features with more corners and details that diverge from the standard rectangular shapes.

Exhibit C 1 summarizes the resulting new net space heating and cooling loads.

Exhibit C 1 New Residential Units—Net Space Heating Loads[48] by Dwelling Type, (kWh/yr.)

Dwelling Types	Tertiary Heating Load (kWh/yr.)			
	Hydro Grid	Large Diesel	Small Diesel	Old Crow
1980 & newer non-electrically heated single detached homes	19,922	19,270	-	-
1980 & newer electrically heated single detached homes	13,284	-	-	-
1980 & newer non-electrically heated attached/row housing	12,724	12,308	-	-
1980 & newer electrically heated attached/row housing	7,263	-	-	-
Non-electrically heated apartment units	10,380	8,535	-	-
Non-electrically heated apartment common areas	25,291	29,287	-	-
Electrically heated apartment units	6,021	-	-	-
Electrically heated apartment common areas	14,669	-	-	-
Non-electrically heated mobile/other	15,062	22,270	-	-
Electrically heated mobile/other	9,287	-	-	-
Small diesel grid housing	-	-	15,693	17,399
Seasonal housing	1,367	1,435	1,065	1,137
Residential garages	9,806	6,962	3,922	9,806

C.1.1 Development of Thermal Archetypes – New Stock

Although the study assumes that the net space heating loads decrease only slightly for new dwellings, the physical and thermal specifications of the new dwellings differ from the existing dwellings. Thus, as in the Base Year discussion, a thermal archetype for each of the major new dwelling types was developed using HOT2000.

For the new housing stock, archetypes were created for the two primary dwelling types in each service region: single-family detached and attached. A brief description of each housing archetype is provided below.

Single detached houses

A typical new single-family detached dwelling can be defined as a single-story bungalow of approximately 170 m^2 (1,800 ft^2), including a finished basement. This home has approximately 19.0 m^2 (205 ft^2) of window area, typically low-e, argon-filled, triple-glazed window units with vinyl frames. Walls are represented by RSI-4.9 (R-28) insulation values, ceilings RSI-8.8 (R-50) and the basement is insulated to a value of RSI-4.9 (R-28) all the way to the basement floor. The houses are reasonably airtight with about 1.5 ACH@50Pa (air changes per hour at 50 Pascal depressurization).

Attached Dwellings

A typical new attached dwelling can be defined as a one-story end unit of approximately 125 m^2 (1,350 ft^2), including a finished basement. This home has 11.5 m^2 (125 ft^2) of windows, typically low-e, argon-filled, triple-glazed window units with vinyl frames. Walls are represented by RSI-RSI-4.9 (R-28) insulation values, ceilings RSI-8.8 (R-50) and the basement is insulated to a value of RSI-4.9 (R-28) all the way to the basement floor. The houses are reasonably airtight, with an air change rate of about 1.5 ACH@50Pa.

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[48] Net space heating load is the space heating load of a building that must be met by the space heating system over a full year. This is equal to the total heat loss through the building envelope minus solar and internal gains. Values shown for non-electrically heated dwellings are shown in kilowatt hours for format consistency.

C.2 Step 2: Natural Changes to Space Heating Loads – Existing Dwellings

In addition to new dwellings, space heating loads in existing dwellings are also expected to change over the study period. However, no specific data are available and, as outlined in the preceding discussion of new dwellings, contrary trends[49] are occurring.

Examples of trends that tend to decrease the net space heating loads include:

- Insulation and other improvements that occur when renovation projects are undertaken
- Replacement of old windows with new models that provide comfort and aesthetic benefits as well as improved energy efficiency
- Installation of more efficient thermostatic controls.

Examples of trends that tend to increase net space heating loads include:

- Enlargement of houses with additions
- Reductions in internal gains due to more efficient appliances and lights.

Dwellings that undergo a major energy retrofit to the building shell are moved from the existing dwelling category into renovated dwellings. On average, these projects are assumed to include two building envelope retrofits (though they may not all happen in the same month), such as replacement of half the windows and the addition of insulation to the attic. In past projects, window replacement has been used as an indicator of the percentage of dwellings being renovated. Window sales are typically divided roughly evenly between installation in new homes and replacement in existing homes. A typical window replacement project involves approximately half the windows in the dwelling. Therefore, the rate of renovation is approximately double the rate of new construction.

Trial energy simulation runs were undertaken in HOT2000, assuming a variety of combinations of retrofit measures. The results varied widely, from a 2% to 15% reduction in space heat and cooling loads, depending on assumptions related to the number of windows replaced, or the part of the house being insulated. These decreases will be partly or wholly offset in those renovation jobs that also increase the floor area of the dwelling.

In the absence of more comprehensive data, this study assumes that a renovation to a home built after 1980 would experience a net reduction in space heating load of 3%. An older home (in which it was assumed more likely there would be an addition to the floor area) would experience a net reduction in space heating load of 2%.

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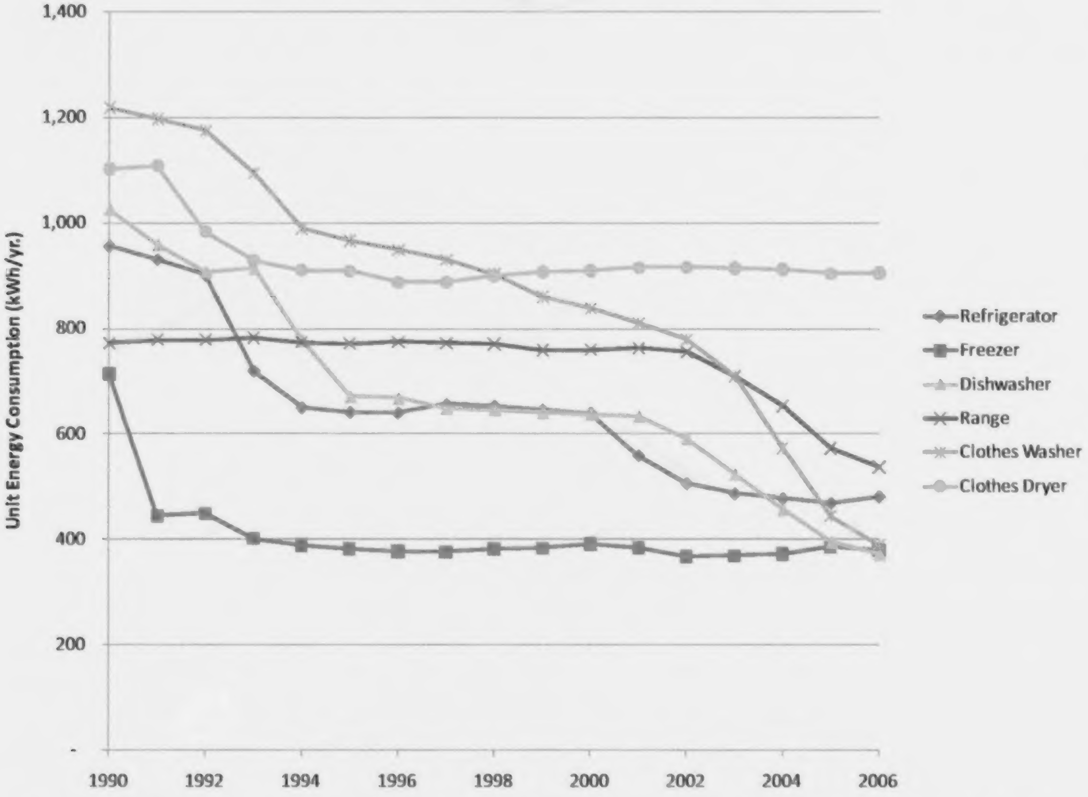
[49] Replacement of the heating equipment itself is not one of these factors because it does not actually change the net heating load.

C.3 Step 3: Natural Changes to Electric Appliance UECs

This section identifies the annual unit electricity consumption (UEC) for the major household appliances and equipment for both "stock in place" and new sales for the period 2010 to 2030.

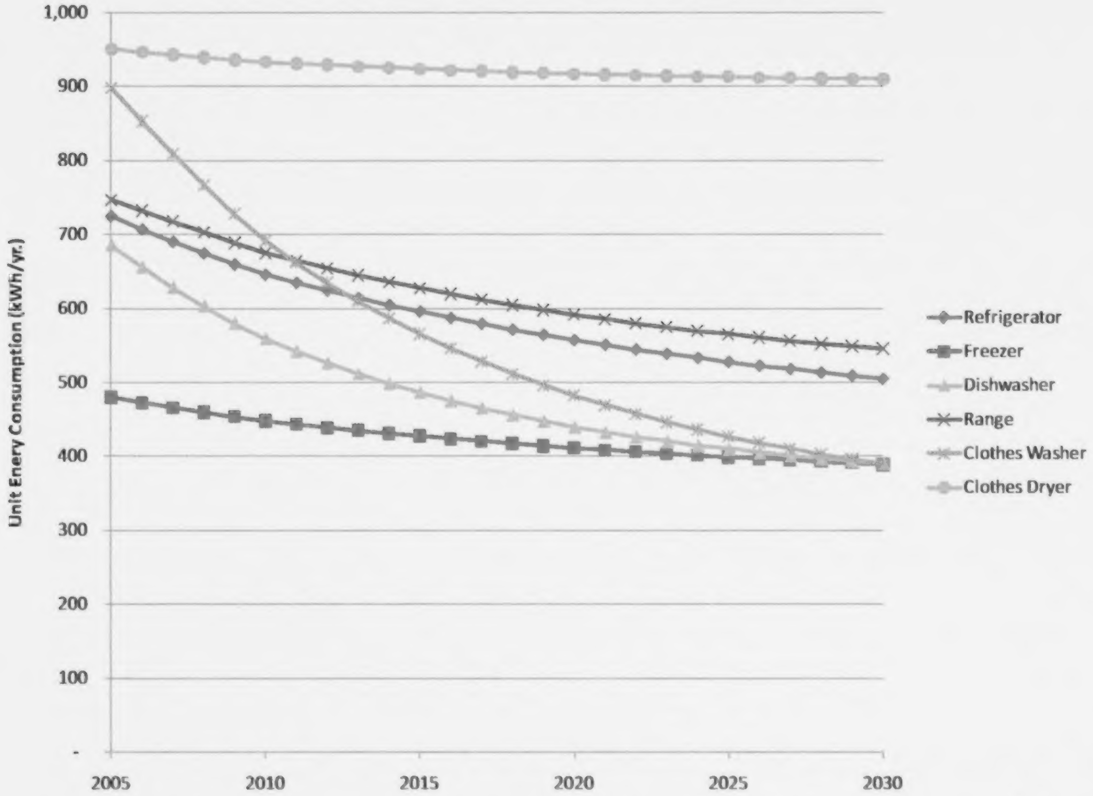
Exhibit C 2 shows Canadian trend information for the new sales of white goods for the period 1990 to 2006. Exhibit C 3 incorporates the average consumption data for new sales into ICF Marbek's appliance stock model to develop forecasts for average consumption of the white goods appliances throughout the study period.

Exhibit C 2 Canadian White Goods, UECs for New Sales



Source: NRCan, *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2006*.

Exhibit C 3 Canadian White Goods, UECs for Existing Stock



Source: Original NRCan UEC data for new sales (see source note for previous exhibit), incorporated into Marbek's appliance stock model.

As shown in Exhibit C 3, the annual UEC for most major household white good type appliances in existing stock is expected to decline steadily until nearly 2020, due to stock turnover and to continuing improvements in new stock. Future regulations or innovations may bring additional improvements in the white goods in the later years of the study period, but no assumptions have been made to that effect. Instead, the consumption of the different appliances is permitted to level off.

Further discussion of the modelled assumptions applied to each of the major appliances follows.

Cooking

A UEC, which includes both ranges and microwave ovens, of 668 kWh/yr. is assumed in the Base Year, declining to 540 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of cooking appliances), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a cooking UEC of 585 kWh/yr. on average, declining to 540 kWh/yr. by 2030.

Refrigerator

A UEC of 614 kWh/yr. is assumed in the Base Year, declining to 479 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore average size of refrigerators), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a refrigerator UEC of 529 kWh/yr. on average, declining to 479 kWh/yr. by 2030.

Freezer

A UEC of 443 kWh/yr. is assumed in the Base Year, declining to 365 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore average size of freezers), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a freezer UEC of 407 kWh/yr. on average, declining to 365 kWh/yr. by 2030.

Dishwasher

A UEC of 108 kWh/yr. is assumed in the Base Year, declining to 75 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of dishwashers), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a dishwasher UEC of 85 kWh/yr. on average, declining to 75 kWh/yr. by 2030.

The values shown are for mechanical energy only. Mechanical energy is assumed to be approximately 19% of the values reflected in Exhibit C3. Hot water use is included with the DHW UEC.

Clothes Washer

A UEC of 61 kWh/yr. is assumed in the Base Year, declining to 34 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of clothes washers), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a clothes washer UEC of 42 kWh/yr. on average, declining to 34 kWh/yr. by 2030.

The values shown are for mechanical energy only. Mechanical energy is assumed to be approximately 9% of the values reflected in Exhibit C3. Hot water use is included with the DHW UEC.

Clothes Dryer

A UEC of 924 kWh/yr. is assumed in the Base Year, declining to 901 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of clothes dryers), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a dryer UEC of 908 kWh/yr. on average, declining to 901 kWh/yr. by 2030.

Ventilation

Ventilation energy in existing stock is assumed to remain constant. This assumption recognizes that there are a number of competing trends that remain unresolved at this time. On the one hand, there is a trend towards manufacturers' use of larger fan motors (1/2-HP versus 1/3-HP) in new furnaces. This means that furnaces replaced in the study period may have a larger furnace fan motor. However, the trend towards larger fan motors is at least partially offset by efficiency improvements. For example, an earlier study for the Canadian Electricity Association (CEA) noted that improved fan design, combined with the use of permanent split capacitor fan motors, had improved furnace fan efficiency by between 13% and 19%.[50]

In new stock, average ventilation energy was assumed to increase by nearly 40%, from the current average of approximately 573 kWh/yr. (including furnace fans, other fans such as exhaust fans in the kitchen, and pumps in boiler systems) to approximately 787 kWh/yr. This value was based on the HOT2000 modeling of newer homes with the furnace fan operating continuously. According to previous studies in other jurisdictions, occupants of newer dwellings are more likely to run their furnace blower fan continuously.

Domestic Hot Water

Exhibit C 4 summarizes the DHW UECs by end use for new dwellings. A comparison with the values presented previously for existing dwellings (see Appendix A) shows a significant reduction for hot water use in clothes washing, with slightly more modest changes for personal consumption.

DHW electricity for new and existing appliances is obtained from NRCan, as discussed above (see Exhibit C 3). For existing and retrofitted buildings, the DHW UEC is assumed to decrease as clothes washers are replaced in the appliance stock, but is otherwise assumed to be constant. The UEC for DHW in new buildings is assumed to be constant.

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[50] Phillips, B. *Blower Efficiency in Domestic Heating Systems*, CEA Report No. 9202-U-921, 1995 and *Optimizing Heat and Air Distribution Systems when Retrofitting Houses with Energy Efficient Equipment*, Canada Mortgage and Housing Corporation, 2002. Ventilation UECs will be higher in dwellings that have air conditioning and/or continuous ventilation.

Exhibit C 4 Distribution of DHW Electricity Use by End Use in New Stock, (kWh/yr.)

DHW Sub End Uses	Electricity per Sub End Use (kWh/yr.)	Electricity per Sub End Use (%)
Clothes Washer	356	13%
Showers	690	26%
Faucets	493	18%
Baths	128	5%
Dishwasher	315	12%
Leaks	192	7%
Tank (Standby) Losses	256	10%
Pipe Losses	256	10%
Total	2,687	100%

Indoor Lighting

The lighting UEC was assumed to decrease as incandescent lamps are phased out and replaced by compact fluorescent lamps. It is assumed that approximately 50% of the remaining incandescent lamps would be replaced by the end of the study period if there was no utility involvement in DSM programming or revision of efficiency standards. Exhibit C 5 shows the assumed lighting counts, average wattage, and hours of use per year used to develop estimates of the overall indoor lighting energy consumption for different dwelling types in 2030.

Exhibit C 5 Indoor Lighting by Dwelling Type, 2030

Dwelling Types	Incandescent Lamps	CFL	Linear Fluorescent Tubes	Halogen Lamps	
SDH	**11**	**28**	**6**	**3**	**(lamps)**
Attached	**8**	**21**	**2**	**2**	**(lamps)**
Apartment	**6**	**15**	**1**	**1**	**(lamps)**
Average Wattage	**60**	**15**	**48**	**50**	**(watts)**
Average Hours/Year	**500**	**500**	**500**	**500**	**(hr/yr.)**
Total Base Year Energy Use (kWh/yr.)					Total
SDH	330	210	144	75	759
Attached	240	158	48	50	496
Apartment	180	113	24	25	342

Outdoor Lighting

The lighting UEC was assumed to decrease as incandescent lamps are phased out and replaced by compact fluorescent lamps. It is assumed that approximately 50% of the remaining incandescent lamps would be replaced by the end of the study period if there was no utility involvement in DSM programming or revision of efficiency standards. Exhibit C 6 shows the assumed lighting counts, average wattage, and hours of use per year used to develop estimates of the overall outdoor lighting energy consumption for different dwelling types in 2030.

Exhibit C 6 Outdoor Lighting by Dwelling Type, 2030

Dwelling Types	Incandescent Lamps	Compact Fluorescent Lamps (long hours)	Compact Fluorescent Lamps (short hours)	Linear Fluorescent Tubes	
SDH	2	2	2	1	(lamps)
Attached	1	1	2	0	(lamps)
Apartment	0	0	1	0	(lamps)
Average Wattage	60	15	15	48	(watts)
Average Hours/Year	900	1800	900	365	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	108	54	27	18	207
Attached	54	27	27	0	108
Apartment	0	0	14	0	14

Holiday Lighting

The holiday lighting UEC was assumed to decrease as incandescent strings are phased out and replaced by LED strings. This transition is assumed to be complete by the end of the study period. Exhibit C 7 shows the assumed lighting counts, average wattage, and hours of use per year used to develop estimates of the overall holiday lighting energy consumption for different dwelling types in 2030.

Exhibit C 7 Holiday Lighting by Dwelling Type, 2030

Dwelling Types	Indoor Incandescent Holiday Strings	Indoor LED Holiday Strings	Outdoor Incandescent Holiday Strings	Outdoor LED Holiday Strings	
SDH	0	11	0	8	(lamps)
Attached	0	6	0	5	(lamps)
Apartment	0	3	0	0	(lamps)
Average Wattage	60	1	60	1	(watts)
Average Hours/Year	95	95	125	125	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	0	1	0	1	2
Attached	0	1	0	1	1
Apartment	0	0	0	0	0

Televisions

The North American television industry has announced its commitment to convert all analog television to digital broadcasting within the next five years. The transition is occurring August 31, 2011, in the large southern television markets, but will take longer in the North. These broadcast changes are occurring at a time when television technology and programming options are also rapidly changing. Some television technology changes, such as the introduction of liquid crystal display (LCD) and plasma models, may also have significant impacts on household electricity consumption. It is also possible that these changes will result in an increased rate of turnover in the current stock of televisions to models that are better able to take advantage of the high definition (HD) digital signal.

LCD is now the dominant television technology. Although LCD screens typically use less electricity per square inch of screen, consumers typically choose screens that are larger when purchasing an LCD screen compared to cathode ray tube screens (CRTs). When CRTs predominated, the most popular size was 27" but consumers are now more likely to buy a 40" widescreen TV, or even larger. This trend has the effect of reducing the electricity advantage that would be gained from a direct switch to the new LCD technology.

In addition to the increase in screen size, HD television models typically consume more power than equivalent standard definition televisions for all technology types. Since the trend with televisions is towards HD sets with greater resolution, television unit electricity use is expected to increase in the future.

In the long term, ENERGY STAR® and improved energy-efficiency standards for electronics will start to bring down the average electricity use per television, even in the absence of new DSM programs in Yukon. The effects of these improvements will likely be masked by the effects of increasing television size and resolution until after 2020.

In light of these changes, UECs for televisions are assumed to increase from 178 kWh/yr. to 210 kWh/yr. by 2020 and then begin to slowly decline, reaching 207 kWh/yr. by 2030. These assumptions draw on both a 2006 Marbek study, *Technology and Market Profile: Consumer Electronics*,[51] and subsequent work for the Ontario Power Authority in 2009.

Television Peripherals

One implication of the pending changes towards digital television broadcasting is that new signal adaptors, commonly referred to as set-top boxes (STBs), will need to be added to nearly two-thirds of Canadian households to receive a television signal.

Industry representatives estimate that each Canadian subscriber household has, on average, 1.5 set-top boxes.[52] They also note that the trend is towards a greater number of STBs per household and, by 2010, the industry estimates that the average will have increased to approximately two STBs per subscriber household. This is further discussed in the saturation section of this appendix (Section C.4).

When complete, the switch to digital broadcasting is expected to increase national STB electricity consumption by up to four times its current level due to the added requirement for STBs among those televisions currently operating on analog cable or over-the-air broadcast signals. Moreover, within these STBs, the most significant trend is towards greater functionality, which is directly associated with further increases in unit electricity consumption.

At the same time, ENERGY STAR® and improved energy-efficiency standards for electronics will begin to affect STBs. Currently, many of these products consume a substantial fraction of their electricity when no one is watching the television. Standards that specify maximum consumption in standby mode will therefore make a dramatic difference in the UEC for these devices.

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[51] Marbek Resource Consultants. Technology and Market Profile: Consumer Electronics, September 2006.

[52] Ibid.

In light of these changes, UECs for television peripherals are assumed to decrease from 225 kWh/yr. to 172 kWh/yr. over the study period.[53] The decrease is more than offset by the increasing saturation, as discussed in Section C.4.

Computers and Peripherals

Electricity consumption for personal computers is expected to decrease modestly, as monitors move to more energy-efficient flat screen technology and ENERGY STAR® increasingly predominates. This is somewhat counteracted by a growing preference for larger screens, a trend towards longer operating hours both in full operating mode and in idle mode, and the increasing numbers of peripherals. The growth in the number of computers per household is discussed in the saturation section of this appendix (Section C.4).

UECs for personal computers and their peripherals are assumed to decrease from 394 kWh/yr. to 384 kWh/yr. over the study period.

Spas

No increase in the size or heating load of spas has been assumed. In a previous Marbek study for the OPA in 2009, assumptions were developed on the trend towards the use of heat pumps to heat pools and spas. By 2030, the electric resistance heaters are assumed to be completely phased out, even in the absence of new DSM programs in Yukon.

The analysis also assumes that high-efficiency pumps will gradually become more popular in the market, without new DSM intervention, reaching a penetration of 60% by 2030.

UECs for spas, including both the electric heating units (resistance or heat pump) and the pumps, are expected to decline from 8,164 kWh/yr. in 2010 to 3,171 kWh/yr. in 2030.

Home Entertainment Electronics

As functionality increases, other entertainment devices, such as computer games and music systems are becoming more powerful. For example, the new PlayStation 3 games console uses 360 Watts compared to its predecessor, which uses only 45 Watts. One of the selling features of the Nintendo Wii and other next generation products is that they can be left on-line for 24 hours a day.

UECs for both the home entertainment electronics category and the small appliances and other category are likely to increase over the study period. UECs for home entertainment electronics are assumed to increase from 106 kWh/yr. to 1,074 kWh/yr. over the study period.

Block Heaters and Car Warmers

No change was assumed in the consumption of block heaters and car warmers over the study period, in the absence of new utility DSM initiatives.

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[53] Ibid.

Heat Tape, Propane Heaters, and Circulation Pumps

No change was assumed in the consumption of heat tape, propane heaters and circulation pumps over the study period, in the absence of new utility DSM initiatives.

Small Appliances and Other

The UECs for the small appliances and other categories increase over the study period in anticipation of new end uses, but there is considerable uncertainty in the amount of this increase.

Based on the changes observed in previous studies, new end uses are constantly emerging, some of which are substantial consumers of electricity. One example is electric vehicle charging. Electric cars and plug-in hybrids could achieve substantial penetration by the end of the study period; charging of a typical electric vehicle would require approximately 7,000 kWh/yr.[54]

The UEC for this category is assumed to increase from 186 kWh/yr. to 1,895 kWh/yr. over the study period. The growth rate in this end use was adjusted to improve the calibration between the model and the Yukon load forecast. Because there is so much uncertainty in the emergence of new "other" end uses and considerably more knowledge of trends in other end uses, this miscellaneous category was used to increase the consumption per account to match the forecast. The forecast changes in consumption per house vary among the four different supply systems. A growth rate of over 12% per year was applied to Small Appliances and Other in order to match the forecast increase in overall consumption per house on the hydro grid. For accounts on large and small diesel systems and the Old Crow system, the growth rates used for Small Appliances and Other were 9%, 4.5%, and 6%, respectively.

C.4 Step 4: Appliance Saturation Trends

To develop estimates of the future saturation of residential equipment, references from Yukon and previous studies in other jurisdictions were reviewed along with data on trends in the increasing use of entertainment-based electronics.

We have applied the growth rates from these sources to estimate saturations to the end of the study period. Increases in the numbers of set-top boxes drew on Marbek's 2006 study.[55] The results are shown in Exhibit C 8.

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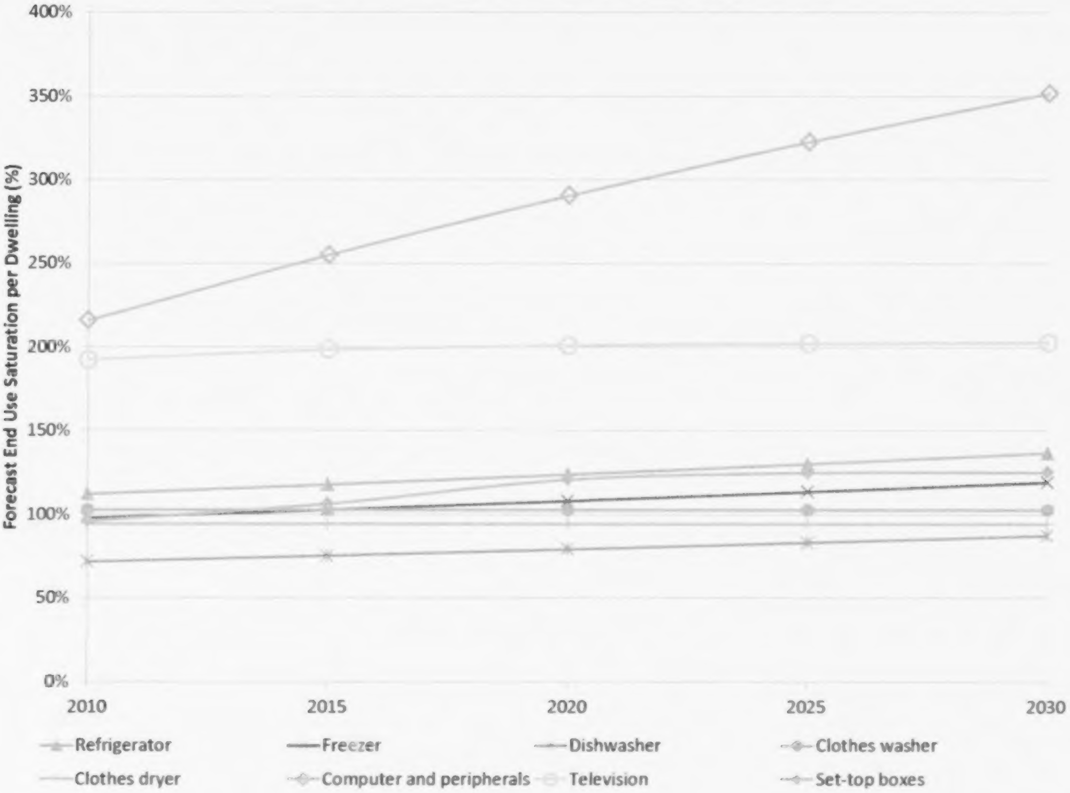
[54] California EPA, Air Resources Board. *Fact Sheet: Battery Electric Vehicles*, Sacramento, CA, 2003, http://www.arb.ca.gov/msprog/zevprog/factsheets/clean_vehicle_incentives.pdf.

[55] Op. cit. *Technology and Market Profile: Consumer Electronics.*

Exhibit C 8 Trends in Appliance Saturation, 2010 to 2030



All of the end-use appliances shown in Exhibit C 8 are forecast to increase in saturation per household. For the white goods end uses, this results in a relatively stable overall consumption per household because the increase in saturation is approximately cancelled out by the decrease in UEC that is expected to occur over the same period. For the three electronics end uses shown in the exhibit, the overall consumption is expected to rise during the period, as increases in saturation will likely have a larger effect than improvements in efficiency.

C.5 Step 5: Fuel Shares

No changes in the fuel shares for any end uses are assumed over the study period.

C.6 Step 6: Estimate Growth in Dwellings, by Type

This step involved the development and application of estimated levels of growth in each dwelling type over the study period.

YEC provided the forecast growth dwelling units as annual percentages for each supply system. The same growth rates were used for all of the dwelling types connected with a given supply system, with one key exception. Where a dwelling type was segmented by vintage, all the growth was applied to the newest vintage.

Exhibit C 9 presents a summary of the resulting percentage stock growth, by year and dwelling type, for Yukon as a whole.

Exhibit C 9 Residential Stock Growth Rates, 2010 to 2030

Dwelling Types	Annualized Stock Growth Rates by Period			
	2010-2015	2015-2020	2020-2025	2025-2030
1980 & newer non-electrically heated single detached homes	1.8%	1.5%	1.3%	1.1%
1980 & newer electrically heated single detached homes	8.2%	6.3%	5.0%	4.1%
Total SDH	1.5%	1.4%	1.3%	1.2%
1980 & newer non-electrically heated attached/row housing	1.9%	1.6%	1.4%	1.1%
1980 & newer electrically heated attached/row housing	13.1%	9.6%	7.6%	6.2%
Total Attached	2.0%	2.1%	2.1%	2.0%
Non-electrically heated apartment units	1.8%	1.6%	1.4%	1.2%
Non-electrically heated apartment common areas	1.7%	1.5%	1.3%	1.2%
Electrically heated apartment units	13.2%	11.7%	10.2%	8.9%
Electrically heated apartment common areas	13.0%	11.5%	10.0%	8.7%
Total Apartment	3.6%	4.0%	4.3%	4.5%
Non-electrically heated mobile/other	1.0%	0.9%	0.8%	0.7%
Electrically heated mobile/other	4.8%	4.2%	3.7%	3.2%
Total Mobile	1.5%	1.4%	1.3%	1.2%
Small diesel grid housing	0.6%	0.6%	0.6%	0.7%
Seasonal housing	1.0%	0.9%	0.8%	0.7%
Residential garages	1.0%	0.9%	0.8%	0.7%
Sentinel Lighting	0.9%	0.8%	0.7%	0.6%
Grand Total	1.6%	1.6%	1.6%	1.6%

The growth rates of different dwelling types differ because they are present in different proportions in the different supply systems. Exhibit C 10 provides growth rates by supply system.

Exhibit C 10 Residential Stock Growth Rates by Supply System, 2010 to 2030

Supply System	Annualized Stock Growth Rates by Period			
	2010-2015	2015-2020	2020-2025	2025-2030
Hydro Grid	1.7%	1.7%	1.7%	1.7%
Large Diesel	0.2%	0.2%	0.2%	0.2%
Small Diesel	0.0%	0.0%	0.0%	0.0%
Old Crow	1.4%	1.4%	1.4%	1.4%
Grand Total	1.6%	1.6%	1.6%	1.6%

C.6 Results by Supply System

This section of the appendix presents the base year electricity consumption for the hydro grid, large diesel, small diesel and Old Crow supply systems. For each supply system, a version of Exhibit 18 is provided below. The underlying assumptions such as unit energy consumption, saturation and electricity share are not presented by supply system. This section also does not replicate the pie charts and other graphs presented in Section 5. If those graphs are needed for each supply system, they can be created using the Data Manager.

Exhibit C 11 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Hydro Grid Accounts (MWh/yr.)

Dwelling Types	Milestone Years	HVAC	Appliances	Electronics	DHW	Other	Lighting	TOTAL
Single Detached House	2010	23,697	22,067	11,820	19,591	13,330	9,273	99,778
	2015	27,153	22,580	14,877	19,617	12,597	9,330	106,154
	2020	30,901	23,778	18,601	19,665	12,299	9,285	114,529
	2025	34,807	25,266	22,821	20,164	15,449	9,120	127,627
	2030	38,773	26,931	28,792	20,627	22,089	8,833	146,045
Apartment/Condo Suites and Common Areas	2010	3,588	2,888	2,038	1,899	1,091	2,032	13,536
	2015	5,138	2,597	2,821	2,100	1,328	2,214	16,198
	2020	7,493	3,025	3,965	2,425	1,765	2,434	21,106
	2025	10,856	3,659	5,547	2,949	2,747	2,678	28,436
	2030	15,393	4,511	8,034	3,653	4,718	2,918	39,227
Attached Dwelling	2010	1,971	2,027	1,446	2,049	1,615	824	9,932
	2015	2,399	2,138	1,855	2,108	1,530	840	10,869
	2020	2,929	2,295	2,369	2,195	1,471	851	12,110
	2025	3,552	2,535	2,963	2,355	1,826	852	14,084
	2030	4,257	2,802	3,795	2,537	2,602	840	16,833
Mobile	2010	2,280	1,798	1,239	2,092	886	841	9,137
	2015	2,620	1,782	1,553	2,095	897	847	9,793
	2020	2,968	1,863	1,930	2,100	965	844	10,670
	2025	3,318	1,969	2,347	2,153	1,279	830	11,896
	2030	3,666	2,090	2,928	2,203	1,886	805	13,579
Garages and Seasonal Housing	2010	383	690	383	744	1,345	895	4,440
	2015	402	689	482	725	1,282	879	4,459
	2020	420	704	620	703	1,257	855	4,559
	2025	436	725	802	697	1,503	821	4,985
	2030	451	750	1,087	688	1,991	779	5,747
Sentinel Lighting	2010	-	-	-	-	-	515	515
	2015	-	-	-	-	-	530	530
	2020	-	-	-	-	-	543	543
	2025	-	-	-	-	-	565	565
	2030	-	-	-	-	-	585	585
TOTAL	2010	31,919	29,470	16,926	26,375	18,268	14,379	137,337
	2015	37,713	29,786	21,587	26,645	17,633	14,641	148,004
	2020	44,712	31,665	27,484	27,088	17,756	14,811	163,517
	2025	52,970	34,155	34,480	28,318	22,804	14,867	187,594
	2030	62,540	37,083	44,636	29,708	33,286	14,762	222,016

Exhibit C 12 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Large Diesel Accounts (MWh/yr.)

Dwelling Types	Milestone Years	Appliances	Electronics	DHW	HVAC	Other	Lighting	TOTAL
Single Detached House	2010	1,127	608	961	782	677	471	4,625
	2015	1,077	713	903	788	596	442	4,519
	2020	1,065	835	846	795	546	413	4,500
	2025	1,064	967	811	802	647	383	4,675
	2030	1,072	1,158	777	809	879	352	5,047
Mobile	2010	163	113	184	155	80	77	771
	2015	151	132	173	156	76	72	760
	2020	149	154	162	158	76	67	766
	2025	148	177	155	159	96	62	796
	2030	148	209	149	160	134	58	857
Attached Dwelling	2010	104	74	100	69	82	42	471
	2015	100	87	95	70	71	39	462
	2020	98	101	89	71	62	36	458
	2025	99	116	86	72	70	33	476
	2030	99	136	83	73	92	30	512
Apartment/Condo Suites and Common Areas	2010	43	24	46	21	76	52	261
	2015	41	29	43	21	70	49	253
	2020	41	35	41	21	67	46	251
	2025	40	45	39	21	81	43	269
	2030	41	59	37	22	108	39	306
Garages and Seasonal Housing	2010	63	49	44	46	15	34	250
	2015	50	58	42	47	17	32	246
	2020	49	68	40	49	21	30	257
	2025	48	79	39	50	30	27	274
	2030	48	95	38	51	46	25	304
Sentinel Lighting	2010	-	-	-	-	-	55	55
	2015	-	-	-	-	-	54	54
	2020	-	-	-	-	-	53	53
	2025	-	-	-	-	-	54	54
	2030	-	-	-	-	-	54	54
TOTAL	2010	1,500	867	1,335	1,072	930	730	6,434
	2015	1,419	1,018	1,256	1,083	829	688	6,294
	2020	1,401	1,194	1,177	1,094	773	645	6,284
	2025	1,400	1,383	1,130	1,104	924	602	6,543
	2030	1,408	1,656	1,084	1,115	1,260	558	7,081

Exhibit C 13 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Small Diesel Accounts (MWh/yr.)

Dwelling Types	Milestone Years	Appliances	DHW	Electronics	Other	Lighting	HVAC	TOTAL
Small Grid Housing	2010	285	282	149	170	133	115	1,133
	2015	275	263	174	147	123	115	1,098
	2020	269	244	204	130	114	115	1,076
	2025	266	232	236	146	105	115	1,099
	2030	265	219	283	183	95	115	1,161
Garages and Seasonal Housing	2010	12	13	7	19	13	3	67
	2015	12	12	8	17	12	3	64
	2020	11	11	10	15	12	3	62
	2025	11	11	12	18	11	3	66
	2030	11	10	16	23	10	3	74
Sentinel Lighting	2010	-	-	-	-	38	-	38
	2015	-	-	-	-	38	-	38
	2020	-	-	-	-	37	-	37
	2025	-	-	-	-	37	-	37
	2030	-	-	-	-	37	-	37
TOTAL	2010	297	295	156	189	184	118	1,239
	2015	287	275	182	164	173	118	1,199
	2020	281	255	213	146	162	118	1,175
	2025	277	242	248	164	152	118	1,201
	2030	276	230	299	206	142	118	1,271

Exhibit C 14 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Old Crow Accounts (MWh/yr.)

Dwelling Types	Milestone Years	Appliances	DHW	Electronics	Other	Lighting	HVAC	TOTAL
Small Grid Housing	2010	225	223	118	134	105	91	895
	2015	232	220	148	127	105	98	929
	2020	243	219	185	125	104	106	982
	2025	259	224	230	160	102	114	1,089
	2030	278	230	296	233	100	123	1,260
Garages and Seasonal Housing	2010	15	16	8	21	15	2	77
	2015	15	16	11	19	15	2	78
	2020	16	16	14	17	15	2	80
	2025	17	16	19	21	15	2	91
	2030	18	17	27	32	15	2	110
Sentinel Lighting	2010	-	-	-	-	1	-	1
	2015	-	-	-	-	1	-	1
	2020	-	-	-	-	1	-	1
	2025	-	-	-	-	1	-	1
	2030	-	-	-	-	1	-	1
TOTAL	2010	240	239	126	155	121	92	973
	2015	248	236	158	145	121	100	1,008
	2020	259	235	199	142	120	107	1,063
	2025	276	240	249	181	118	116	1,180
	2030	296	246	323	265	116	125	1,371

Appendix D Background-Section 6: Reference Case Peak Load

Introduction

The following exhibits show the Reference Case peak load profiles for each supply system.

Exhibit D 1 Electric Peak Loads, by Milestone Year, Peak Period and Dwelling Type, Hydro Grid Accounts (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	2010	23.8	22.2	16.6
	2015	25.4	23.9	17.6
	2020	27.4	25.9	18.9
	2025	30.2	28.6	20.9
	2030	33.7	32.0	23.4
Apartments	2010	3.4	3.2	2.0
	2015	4.1	4.0	2.4
	2020	5.4	5.3	3.2
	2025	7.3	7.2	4.4
	2030	10.0	9.9	6.1
Attached/Row Houses	2010	2.2	2.1	1.6
	2015	2.5	2.4	1.7
	2020	2.8	2.7	1.9
	2025	3.2	3.1	2.2
	2030	3.8	3.7	2.6
Mobile/Other	2010	2.2	2.0	1.6
	2015	2.4	2.2	1.7
	2020	2.6	2.4	1.8
	2025	2.9	2.7	2.0
	2030	3.2	3.0	2.3
Seasonal & Garage	2010	0.9	0.9	0.7
	2015	0.9	0.9	0.7
	2020	0.9	0.9	0.7
	2025	1.0	1.0	0.7
	2030	1.1	1.1	0.8
Sentinel Lighting	2010	0.1	0.1	0.1
	2015	0.1	0.1	0.1
	2020	0.1	0.1	0.1
	2025	0.1	0.1	0.1
	2030	0.1	0.1	0.1
Grand Total	2010	32.5	30.6	22.5
	2015	35.4	33.4	24.3
	2020	39.3	37.3	26.7
	2025	44.7	42.6	30.3
	2030	52.0	49.7	35.3

Exhibit D 2 Electric Peak Loads, by Milestone Year, Peak Period and Dwelling Type, Large Diesel Accounts (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	2010	1.05	0.98	0.73
	2015	1.02	0.95	0.71
	2020	1.01	0.94	0.69
	2025	1.02	0.96	0.71
	2030	1.07	1.01	0.74
Mobile/Other	2010	0.17	0.16	0.13
	2015	0.18	0.16	0.13
	2020	0.18	0.16	0.12
	2025	0.18	0.16	0.13
	2030	0.19	0.17	0.13
Attached/Row Houses	2010	0.10	0.10	0.07
	2015	0.10	0.09	0.07
	2020	0.10	0.09	0.07
	2025	0.10	0.10	0.07
	2030	0.11	0.10	0.07
Apartments	2010	0.06	0.05	0.04
	2015	0.05	0.05	0.04
	2020	0.05	0.05	0.04
	2025	0.06	0.05	0.04
	2030	0.06	0.06	0.04
Seasonal & Garage	2010	0.05	0.05	0.04
	2015	0.05	0.05	0.04
	2020	0.05	0.05	0.04
	2025	0.05	0.05	0.04
	2030	0.06	0.06	0.04
Sentinel Lighting	2010	0.01	0.01	0.01
	2015	0.01	0.01	0.01
	2020	0.01	0.01	0.01
	2025	0.01	0.01	0.01
	2030	0.01	0.01	0.01
Grand Total	2010	1.45	1.35	1.02
	2015	1.42	1.32	0.99
	2020	1.40	1.31	0.97
	2025	1.43	1.34	0.99
	2030	1.49	1.41	1.04

Exhibit D 3 Electric Peak Loads, by Milestone Year, Peak Period and Dwelling Type, Small Diesel Accounts (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Small Grid Houses	2010	0.25	0.23	0.18
	2015	0.24	0.22	0.17
	2020	0.23	0.21	0.16
	2025	0.23	0.21	0.16
	2030	0.24	0.22	0.17
Seasonal & Garage	2010	0.01	0.01	0.01
	2015	0.01	0.01	0.01
	2020	0.01	0.01	0.01
	2025	0.01	0.01	0.01
	2030	0.01	0.01	0.01
Sentinel Lighting	2010	0.01	0.01	0.01
	2015	0.01	0.01	0.01
	2020	0.01	0.01	0.01
	2025	0.01	0.01	0.01
	2030	0.01	0.01	0.01
Grand Total	2010	0.27	0.25	0.20
	2015	0.26	0.24	0.19
	2020	0.25	0.23	0.18
	2025	0.25	0.23	0.18
	2030	0.26	0.24	0.19

Exhibit D 4 Electric Peak Loads, by Milestone Year, Peak Period and Dwelling Type, Old Crow Accounts (MW)

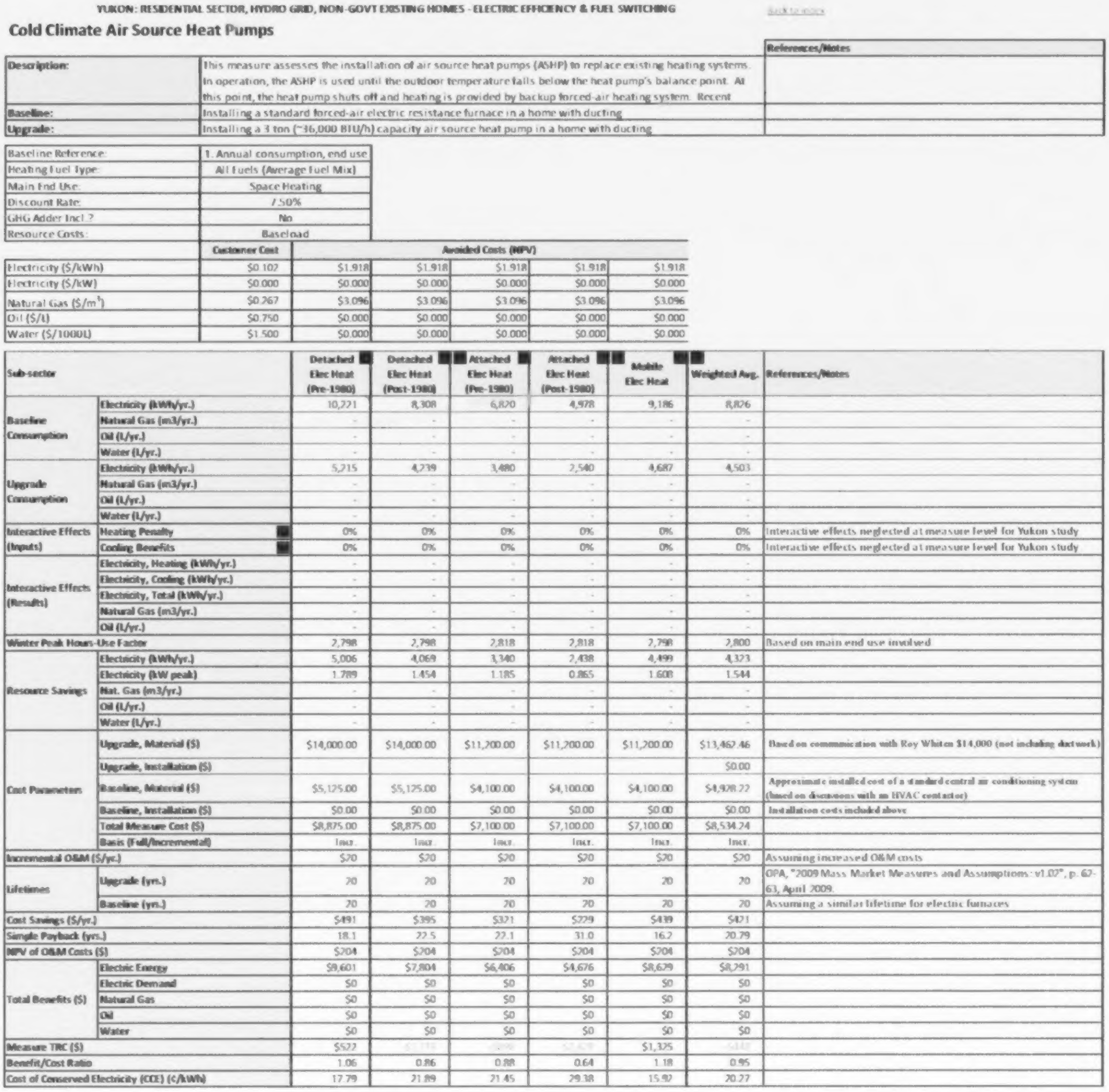
Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Small Grid Houses	2010	0.20	0.18	0.14
	2015	0.20	0.19	0.14
	2020	0.21	0.19	0.15
	2025	0.23	0.21	0.16
	2030	0.25	0.24	0.18
Seasonal & Garage	2010	0.01	0.01	0.01
	2015	0.01	0.01	0.01
	2020	0.02	0.01	0.01
	2025	0.02	0.02	0.01
	2030	0.02	0.02	0.02
Sentinel Lighting	2010	0.00	0.00	0.00
	2015	0.00	0.00	0.00
	2020	0.00	0.00	0.00
	2025	0.00	0.00	0.00
	2030	0.00	0.00	0.00
Grand Total	2010	0.21	0.19	0.15
	2015	0.22	0.20	0.16
	2020	0.23	0.21	0.16
	2025	0.24	0.23	0.17
	2030	0.27	0.26	0.20

Appendix E Background-Section 7: Technology Assessment: Energy-efficiency Measures

Introduction

Exhibit E 1 provides an example of part of the worksheet that calculates the CCE for programmable thermostats, one of the analyzed measures. For more detail on this and all the other measures, refer to the measure TRC model Excel workbooks submitted with this deliverable.

Exhibit E 1 Sample Measure CCE Calculation Worksheet



YUKON: RESIDENTIAL SECTOR, HYDRO GRID, NON-GOVT EXISTING HOMES - ELECTRIC EFFICIENCY & FUEL SWITCHING

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Cold Climate Air Source Heat Pumps

		References/Notes
Description:	This measure assesses the installation of air source heat pumps (ASHP) to replace existing heating systems. In operation, the ASHP is used until the outdoor temperature falls below the heat pump's balance point. At this point, the heat pump shuts off and heating is provided by backup forced-air heating system. Recent	
Baseline:	Installing a standard forced-air electric resistance furnace in a home with ducting	
Upgrade:	Installing a 3 ton (~36,000 BTU/h) capacity air source heat pump in a home with ducting	

Baseline Reference:	1. Annual consumption, end use
Heating Fuel Type:	All Fuels (Average Fuel Mix)
Main End Use:	Space Heating
Discount Rate:	7.50%
GHG Adder Incl.?	No
Resource Costs:	Baseload

	Customer Cost	Avoided Costs (NPV)				
Electricity ($/kWh)	$0.102	$1.918	$1.918	$1.918	$1.918	$1.918
Electricity ($/kW)	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000
Natural Gas ($/m^3)	$0.267	$3.096	$3.096	$3.096	$3.096	$3.096
Oil ($/L)	$0.750	$0.000	$0.000	$0.000	$0.000	$0.000
Water ($/1000L)	$1.500	$0.000	$0.000	$0.000	$0.000	$0.000

Sub-sector		**Detached Elec Heat (Pre-1980)**	**Detached Elec Heat (Post-1980)**	**Attached Elec Heat (Pre-1980)**	**Attached Elec Heat (Post-1980)**	**Mobile Elec Heat**	**Weighted Avg.**	**References/Notes**
Baseline Consumption	**Electricity (kWh/yr.)**	10,221	8,308	6,820	4,978	9,186	8,826	
	Natural Gas (m3/yr.)	-	-	-	-	-	-	
	Oil (L/yr.)	-	-	-	-	-	-	
	Water (L/yr.)	-	-	-	-	-	-	
Upgrade Consumption	**Electricity (kWh/yr.)**	5,215	4,239	3,480	2,540	4,687	4,503	
	Natural Gas (m3/yr.)	-	-	-	-	-	-	
	Oil (L/yr.)	-	-	-	-	-	-	
	Water (L/yr.)	-	-	-	-	-	-	
Interactive Effects (Inputs)	**Heating Penalty**	0%	0%	0%	0%	0%	0%	Interactive effects neglected at measure level for Yukon study
	Cooling Benefits	0%	0%	0%	0%	0%	0%	Interactive effects neglected at measure level for Yukon study
Interactive Effects (Results)	**Electricity, Heating (kWh/yr.)**	-	-	-	-	-	-	
	Electricity, Cooling (kWh/yr.)	-	-	-	-	-	-	
	Electricity, Total (kWh/yr.)	-	-	-	-	-	-	
	Natural Gas (m3/yr.)	-	-	-	-	-	-	
	Oil (L/yr.)	-	-	-	-	-	-	
Winter Peak Hours-Use Factor		2,798	2,798	2,818	2,818	2,798	2,800	Based on main end use involved
Resource Savings	**Electricity (kWh/yr.)**	5,006	4,069	3,340	2,438	4,499	4,323	
	Electricity (kW peak)	1.789	1.454	1.185	0.865	1.608	1.544	
	Nat. Gas (m3/yr.)	-	-	-	-	-	-	
	Oil (L/yr.)	-	-	-	-	-	-	
	Water (L/yr.)	-	-	-	-	-	-	
Cost Parameters	**Upgrade, Material ($)**	$14,000.00	$14,000.00	$11,200.00	$11,200.00	$11,200.00	$13,462.46	Based on communication with Roy Whiten $14,000 (not including ductwork)
	Upgrade, Installation ($)						$0.00	
	Baseline, Material ($)	$5,125.00	$5,125.00	$4,100.00	$4,100.00	$4,100.00	$4,928.22	Approximate installed cost of a standard central air conditioning system (based on discussions with an HVAC contractor)
	Baseline, Installation ($)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	Installation costs included above
	Total Measure Cost ($)	$8,875.00	$8,875.00	$7,100.00	$7,100.00	$7,100.00	$8,534.24	
	Basis (Full/Incremental)	Incr.	Incr.	Incr.	Incr.	Incr.	Incr.	
Incremental O&M ($/yr.)		$20	$20	$20	$20	$20	$20	Assuming increased O&M costs
Lifetimes	**Upgrade (yrs.)**	20	20	20	20	20	20	OPA, "2009 Mass Market Measures and Assumptions: v1.02", p. 62-63, April 2009.
	Baseline (yrs.)	20	20	20	20	20	20	Assuming a similar lifetime for electric furnaces
Cost Savings ($/yr.)		$491	$395	$321	$229	$439	$421	
Simple Payback (yrs.)		18.1	22.5	22.1	31.0	16.2	20.79	
NPV of O&M Costs ($)		$204	$204	$204	$204	$204	$204	
Total Benefits ($)	**Electric Energy**	$9,601	$7,804	$6,406	$4,676	$8,629	$8,291	
	Electric Demand	$0	$0	$0	$0	$0	$0	
	Natural Gas	$0	$0	$0	$0	$0	$0	
	Oil	$0	$0	$0	$0	$0	$0	
	Water	$0	$0	$0	$0	$0	$0	
Measure TRC ($)		$522	[illegible]	[illegible]	[illegible]	$1,325	[illegible]	
Benefit/Cost Ratio		1.06	0.86	0.88	0.64	1.18	0.95	
Cost of Conserved Electricity (CCE) (¢/kWh)		17.79	21.89	21.45	29.38	15.92	20.27	

Appendix F Background-Section 8: Economic Potential: Electric Energy Forecast

Introduction

The following four exhibits provide the economic potential results for the hydro grid, large diesel, small diesel and Old Crow accounts, respectively.

Exhibit F 1 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Hydro Grid Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Space heating	Domestic hot water (DHW)	Indoor lighting	Computer and peripherals	Clothes dryer	Television	Block heaters & car warmers	Refrigerator	Spa heaters and pumps
Single Detached House	2015	10,933	4,000	3,652	1,727	2,111	778	676	281	1,042
	2020	13,094	4,497	3,423	1,980	2,380	1,145	728	602	684
	2025	15,326	5,004	3,131	2,559	2,672	1,224	779	916	585
	2030	17,665	5,434	2,727	3,238	2,835	1,362	828	1,001	574
Apartment/Condo Suites and Common Areas	2015	610	508	1,161	335	209	151	177	38	45
	2020	1,366	742	1,222	437	256	253	216	89	34
	2025	2,456	1,080	1,278	655	332	313	267	152	34
	2030	3,936	1,521	1,304	974	415	410	331	190	39
Attached Dwelling	2015	888	460	388	221	200	99	86	30	134
	2020	1,198	551	374	262	221	151	96	64	91
	2025	1,561	659	353	351	245	168	107	102	81
	2030	1,965	776	322	463	271	195	118	115	83
Mobile	2015	961	436	361	182	120	82	71	22	56
	2020	1,116	473	342	209	128	121	77	46	37
	2025	1,269	512	316	270	136	129	82	70	31
	2030	1,419	548	280	342	145	144	87	76	31
Garages and Seasonal Housing	2015	3	-	350	-	-	-	22	-	-
	2020	3	-	319	-	-	-	23	-	-
	2025	3	-	284	-	-	-	24	-	-
	2030	4	-	241	-	-	-	25	-	-
Sentinel Lighting	2015	-	-	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-	-	-
	2030	-	-	-	-	-	-	-	-	-
Totals	2015	13,395	5,404	5,912	2,465	2,640	1,111	1,033	371	1,276
	2020	16,777	6,264	5,680	2,888	2,986	1,670	1,140	801	846
	2025	20,615	7,254	5,363	3,835	3,386	1,835	1,258	1,240	731
	2030	24,990	8,280	4,874	5,017	3,665	2,111	1,390	1,382	727

Exhibit F 1 Continued: Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Hydro Grid Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Ventilation & circulation	Home entertainment electronics	Outdoor lighting	Freezer	Clothes washer	Set-top boxes	Dishwasher	Holiday lighting	Grand Total
Single Detached House	2015	922	109	363	61	127	-	24	80	26,887
	2020	773	177	263	133	121	-	51	54	30,105
	2025	600	475	148	220	122	101	60	28	33,950
	2030	382	1,152	23	323	120	215	66	6	37,951
Apartment/Condo Suites and Common Areas	2015	7	16	58	8	12	-	2	15	3,353
	2020	19	29	55	19	13	-	5	13	4,766
	2025	35	90	47	36	15	26	7	8	6,832
	2030	58	257	34	60	17	65	9	2	9,621
Attached Dwelling	2015	96	10	36	6	12	-	2	6	2,674
	2020	83	17	26	14	11	-	4	4	3,169
	2025	68	47	14	24	11	14	6	2	3,813
	2030	49	119	2	37	11	31	6	1	4,564
Mobile	2015	141	10	37	5	7	-	1	6	2,499
	2020	126	16	27	10	6	-	3	4	2,741
	2025	109	44	15	17	6	11	3	2	3,023
	2030	88	106	2	25	6	23	3	0	3,326
Garages and Seasonal Housing	2015	1	-	35	-	-	-	-	-	410
	2020	1	-	24	-	-	-	-	-	370
	2025	1	-	13	-	-	-	-	-	326
	2030	0	-	2	-	-	-	-	-	273
Sentinel Lighting	2015	-	-	108	-	-	-	-	-	-
	2020	-	-	111	-	-	-	-	-	-
	2025	-	-	115	-	-	-	-	-	-
	2030	-	-	119	-	-	-	-	-	-
Totals	2015	1,167	145	637	80	158	-	30	107	35,823
	2020	1,002	239	505	177	152	-	63	74	41,151
	2025	813	656	354	297	154	151	76	40	47,944
	2030	578	1,633	181	444	156	333	85	9	55,735

Exhibit F 2 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Large Diesel Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Domestic hot water (DHW)	Indoor lighting	Computer and peripherals	Clothes dryer	Television	Block heaters & car warmers	Ventilation & circulation	Spa heaters and pumps	Refrigerator
Single Detached House	2015	172	173	83	112	37	32	50	49	13
	2020	163	152	89	112	52	33	40	30	26
	2025	156	131	109	113	52	33	28	24	37
	2030	148	109	131	114	55	33	14	22	38
Mobile	2015	34	31	15	10	7	6	16	5	2
	2020	32	27	17	10	10	6	14	3	4
	2025	30	24	20	10	10	6	11	2	5
	2030	29	20	24	10	10	6	8	2	5
Attached Dwelling	2015	18	18	10	9	5	4	0	6	1
	2020	17	16	11	9	6	4	0	4	3
	2025	17	14	14	10	7	4	0	3	4
	2030	16	11	17	10	7	4	0	3	4
Apartment/Condo Suites and Common Areas	2015	5	17	7	2	3	2	-	0	1
	2020	6	15	8	3	4	2	-	0	1
	2025	6	13	9	4	4	2	-	0	2
	2030	6	11	11	4	5	2	-	0	2
Garages and Seasonal Housing	2015	-	19	-	-	-	1	-	-	-
	2020	-	17	-	-	-	1	-	-	-
	2025	-	15	-	-	-	1	-	-	-
	2030	-	12	-	-	-	1	-	-	-
Sentinel Lighting	2015	-	-	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-	-	-
	2030	-	-	-	-	-	-	-	-	-
Totals	2015	229	258	116	133	52	45	66	60	17
	2020	219	228	124	135	72	46	54	37	34
	2025	209	197	152	136	73	46	39	30	48
	2030	199	163	183	137	77	47	23	28	49

Exhibit F 2 Continued: Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Hydro Grid Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Home entertainment electronics	Outdoor lighting	Freezer	Clothes washer	Set-top boxes	Dishwasher	Holiday lighting		Space heating	Grand Total
Single Detached House	2015	5	2	3	7	-	1	4	-	25	719
	2020	8	2	6	6	-	2	2	-	26	697
	2025	20	1	9	5	4	2	1	-	27	700
	2030	46	1	13	5	9	2	0	-	28	711
Mobile	2015	1	0	0	1	-	0	0	-	3	125
	2020	1	0	1	1	-	0	0	-	3	122
	2025	3	0	1	0	1	0	0	-	3	122
	2030	8	0	2	0	2	0	0	-	3	124
Attached Dwelling	2015	0	0	0	1	-	0	0	-	2	72
	2020	1	0	1	0	-	0	0	-	3	71
	2025	2	0	1	0	1	0	0	-	3	73
	2030	4	0	1	0	1	0	0	-	3	76
Apartment/Condo Suites and Common Areas	2015	0	0	0	0	-	0	0	-	1	37
	2020	0	0	0	0	-	0	0	-	1	40
	2025	1	0	0	0	0	0	0	-	1	42
	2030	3	0	1	0	1	0	0	-	1	45
Garages and Seasonal Housing	2015	-	0	-	-	-	-	-	-	0	20
	2020	-	0	-	-	-	-	-	-	0	18
	2025	-	0	-	-	-	-	-	-	0	16
	2030	-	0	-	-	-	-	-	-	0	13
Sentinel Lighting	2015	-	11	-	-	-	-	-		-	11
	2020	-	11	-	-	-	-	-		-	11
	2025	-	11	-	-	-	-	-		-	11
	2030	-	11	-	-	-	-	-		-	11
Totals	2015	7	14	4	8	-	1	5	-	33	984
	2020	10	13	8	7	-	3	3	-	33	959
	2025	26	13	12	6	6	3	2	-	34	964
	2030	61	12	16	6	12	3	0	-	36	980

Exhibit F 3 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Small Diesel Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Indoor lighting	Domestic hot water (DHW)	Computer and peripherals	Clothes dryer	Television	Outdoor lighting	Block heaters & car warmers	Refrigerator	Spa heaters and pumps
Single Detached House	**2015**	**48.3**	**41.6**	**20.0**	**9.7**	**9.0**	**0.6**	**7.8**	**3.7**	**12.1**
	2020	**42.1**	**42.8**	**21.3**	**19.2**	**12.3**	**0.5**	**7.8**	**7.2**	**7.3**
	2025	**36.0**	**42.9**	**25.7**	**26.8**	**12.3**	**0.3**	**7.8**	**10.1**	**5.9**
	2030	**29.5**	**39.6**	**30.6**	**26.7**	**12.9**	**0.2**	**7.8**	**10.1**	**5.4**
Sentinel Lighting	**2015**	-	-	-	-	-	**7.7**	-	-	-
	2020	-	-	-	-	-	**7.5**	-	-	-
	2025	-	-	-	-	-	**7.5**	-	-	-
	2030	-	-	-	-	-	**7.4**	-	-	-
Garages and Seasonal Housing	**2015**	**5.0**	-	-	-	-	**0.1**	**0.1**	-	-
	2020	**4.3**	-	-	-	-	**0.0**	**0.1**	-	-
	2025	**3.7**	-	-	-	-	**0.0**	**0.1**	-	-
	2030	**3.0**	-	-	-	-	**0.0**	**0.1**	-	-
Totals	2015	53.3	41.6	20.0	9.7	9.0	8.3	7.9	3.7	12.1
	2020	46.4	42.8	21.3	19.2	12.3	8.0	7.9	7.2	7.3
	2025	39.7	42.9	25.7	26.8	12.3	7.8	7.9	10.1	5.9
	2030	32.5	39.6	30.6	26.7	12.9	7.7	7.9	10.1	5.4

Dwelling Type	Milestone Year	Ventilation & circulation	Home entertainment electronics	Freezer	Clothes washer	Set-top boxes	Dishwasher	Holiday lighting	Space heating	Grand Total
Single Detached House	**2015**	**2.7**	**1.4**	**0.8**	**0.6**	-	**0.3**	**1.1**	-	**159.6**
	2020	**5.7**	**2.2**	**1.6**	**1.0**	-	**0.6**	**0.7**	-	**172.2**
	2025	**9.1**	**5.5**	**2.5**	**1.2**	**1.0**	**0.6**	**0.3**	-	**188.0**
	2030	**6.5**	**12.4**	**3.4**	**1.1**	**2.0**	**0.6**	**0.1**	-	**189.1**
Sentinel Lighting	**2015**	-	-	-	-	-	-	-	-	**7.7**
	2020	-	-	-	-	-	-	-	-	**7.5**
	2025	-	-	-	-	-	-	-	-	**7.5**
	2030	-	-	-	-	-	-	-	-	**7.4**
Garages and Seasonal Housing	**2015**	-	-	-	-	-	-	- -	**0.1**	**5.1**
	2020	-	-	-	-	-	-	- -	**0.1**	**4.4**
	2025	-	-	-	-	-	-	- -	**0.1**	**3.8**
	2030	-	-	-	-	-	-	- -	**0.0**	**3.1**
Totals	2015	2.7	1.4	0.8	0.6	-	0.3	1.1 -	0.1	172.3
	2020	5.7	2.2	1.6	1.0	-	0.6	0.7 -	0.1	184.2
	2025	9.1	5.5	2.5	1.2	1.0	0.6	0.3 -	0.1	199.3
	2030	6.5	12.4	3.4	1.1	2.0	0.6	0.1 -	0.0	199.6

Exhibit F 4 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Old Crow Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Domestic hot water (DHW)	Indoor lighting	Computer and peripherals	Clothes dryer	Television	Ventilation & circulation	Block heaters & car warmers	Spa heaters and pumps	Refrigerator
Single Detached House	**2015**	**38.0**	**40.9**	**16.9**	**8.2**	**7.6**	**10.8**	**6.6**	**10.2**	**2.8**
	2020	**44.9**	**38.3**	**19.3**	**17.5**	**11.2**	**9.5**	**7.1**	**6.7**	**6.0**
	2025	**51.5**	**35.1**	**25.1**	**26.2**	**12.0**	**8.0**	**7.6**	**5.7**	**9.1**
	2030	**55.6**	**30.9**	**32.0**	**28.0**	**13.5**	**6.3**	**8.2**	**5.6**	**10.1**
Garages and Seasonal Housing	**2015**	-	**6.0**	-	-	-	-	-	-	-
	2020	-	**5.6**	-	-	-	-	-	-	-
	2025	-	**5.1**	-	-	-	-	-	-	-
	2030	-	**4.5**	-	-	-	-	-	-	-
Sentinel Lighting	**2015**	-	-	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-	-	-
	2030	-	-	-	-	-	-	-	-	-
Totals	2015	38.0	46.9	16.9	8.2	7.6	10.8	6.6	10.2	2.8
	2020	44.9	43.9	19.3	17.5	11.2	9.5	7.1	6.7	6.0
	2025	51.5	40.3	25.1	26.2	12.0	8.0	7.6	5.7	9.1
	2030	55.6	35.4	32.0	28.0	13.5	6.3	8.2	5.6	10.1

Dwelling Type	Milestone Year	Home entertainment electronics	Freezer	Clothes washer	Set-top boxes	Outdoor lighting	Dishwasher	Holiday lighting	Space heating	Grand Total
Single Detached House	**2015**	**1.2**	**0.6**	**0.5**	-	**0.5**	**0.2**	**0.9**	-	**146.1**
	2020	**2.0**	**1.3**	**0.9**	-	**0.4**	**0.5**	**0.6**	-	**166.1**
	2025	**5.3**	**2.2**	**1.2**	**1.0**	**0.3**	**0.6**	**0.3**	-	**191.3**
	2030	**13.0**	**3.3**	**1.2**	**2.1**	**0.3**	**0.7**	**0.1**	-	**210.9**
Garages and Seasonal Housing	**2015**	-	-	-	-	**0.1**	-	- -	**0.1**	**6.0**
	2020	-	-	-	-	**0.1**	-	- -	**0.1**	**5.6**
	2025	-	-	-	-	**0.0**	-	- -	**0.1**	**5.1**
	2030	-	-	-	-	**0.0**	-	- -	**0.1**	**4.5**
Sentinel Lighting	**2015**	-	-	-	-	**0.2**	-	-	-	**0.2**
	2020	-	-	-	-	**0.2**	-	-	-	**0.2**
	2025	-	-	-	-	**0.2**	-	-	-	**0.2**
	2030	-	-	-	-	**0.2**	-	-	-	**0.2**
Totals	2015	1.2	0.6	0.5	-	0.8	0.2	0.9 -	0.1	152.3
	2020	2.0	1.3	0.9	-	0.7	0.5	0.6 -	0.1	171.9
	2025	5.3	2.2	1.2	1.0	0.6	0.6	0.3 -	0.1	196.7
	2030	13.0	3.3	1.2	2.1	0.5	0.7	0.1 -	0.1	215.6

Appendix G Background-Section 9: Peak Load Measures

Introduction

Appendix G provides additional detailed information related to analysis of the electric peak load measures. For each of the measures considered, a description is provided, along with details on assumptions, factors included in the economic analysis, barriers and constraints, and program issues. Measure lifecycle costing worksheets for each measure are provided at the end of the appendix.

Overview

Electric peak load measures are typically implemented by utilities to avoid or defer the costs of capacity expansion. Capacity costs refer to all levels of capital-based investments, including generating stations (new and upgraded), transmission and distribution lines, along with substations, transformers and other infrastructure required to deliver power, primarily related to peak capacity driven requirements.

Supply capacity can be purchased, but infrastructure must still be available to deliver the supply to customers. DSM measures that reduce peak requirements avoid and/or defer these capital-intensive investments.

From the customer's side, adoption of electric peak reduction strategies is typically dependent on the overall benefits to them, including direct incentive payments or rate benefits. Under most current rates for residential (and small commercial) customers, customers are billed only for electric energy (kWh) regardless of when it is used, and not for "demand." Consequently, electric peak load measures that do not also reduce overall energy consumption do not provide any financial benefits to customers. However, the industry trend is towards more specific pricing, including time-of-use and even hourly pricing, or peak incentives that pass along some of the utility benefits to customers on a performance basis. These new pricing structures provide incentive for even residential customers to implement measures or to participate in utility peak load reduction programs, as long as the differential between peak and off-peak prices are sufficient to provide a noticeable bill saving potential. To date, these options have been limited by the availability and cost of suitable metering technology, both intra and remote house/facility data communications, and by energy measurement storage options that would enable remote and/or automated measurement and control of devices in the home.

Description of Electric Peak Reduction Measures

The following sub sections provide a description of each of the measures listed in Exhibit 40. The discussion is organized by major end use and is presented in the following sub sections:

- Water heating
- Block heater timers and storage
- Lighting
- Thermal energy storage for supplemental heating.

The discussion of each measure is organized as follows.

- Description
- Assumptions on applicability (dwelling type, unit types, vintage)

- Typical costs – one-time, incremental, operating costs
- Typical electric peak reductions
- Other benefits
- Useful life
- Barriers and constraints for economic and achievable implementation
- Program issues.

Water Heating

Switch-based Water Heating Unit Load Control
Assumptions used for Analysis

Applicable Dwelling Type(s)	▪ Single-family detached and attached, row houses, multi-family – all with individual dwelling unit control/circuits
Applicable Equipment Type	▪ Water heater with at least a 40-gallon tank
Vintage	▪ Existing and new
Costs	▪ $200 incremental cost in existing and new homes ▪ $125 incremental cost as a add-on to an existing control system ▪ Approximately $10/site/yr. maintenance/evaluation
Electric Peak Reduction	▪ 100% reduction in water heating end use evening peaks ▪ About 80% of non-standby water heating energy reduction during curtailment is recovered
Useful Life	▪ 10 years

Description

Switch-based water heating load control is accomplished by the installation of a remote control switch on either the water heater itself or on the circuits controlling the water heater. In older systems, this type of control has been accomplished via radio frequency (RF) control, which allows remote shut off of the water heater under specific capacity-constrained conditions during a limited number of pre-specified hours during winter peak months. In the systems that are currently offered, pager-based communications are used. An even more economic solution is to piggyback off of an already existing communications system. For example, if space heat control already exists, water heat control can be added via a hard-wired or wireless connection. This can significantly reduce the total cost of the water heat control.

Depending upon the length of the control, when the control is operated, and the size of the water heater tank, units can be shut off for the entire control period or cycled to limit their on time to a predetermined number of minutes per control cycle. Water heat control is commercially available and implemented in hundreds of thousands of sites in the U.S., thus demonstrating the viability of the technology, success of the programs, customer acceptance and utility satisfaction.

Applicability

Applicable dwelling types are any dwelling units with a water heater that has at least a 40-gallon tank. The size of the tank is important because it provides hot water during times when the control is in effect. The larger the water heater tank, the longer the control can be in place without disrupting the customer's comfort and living conditions.

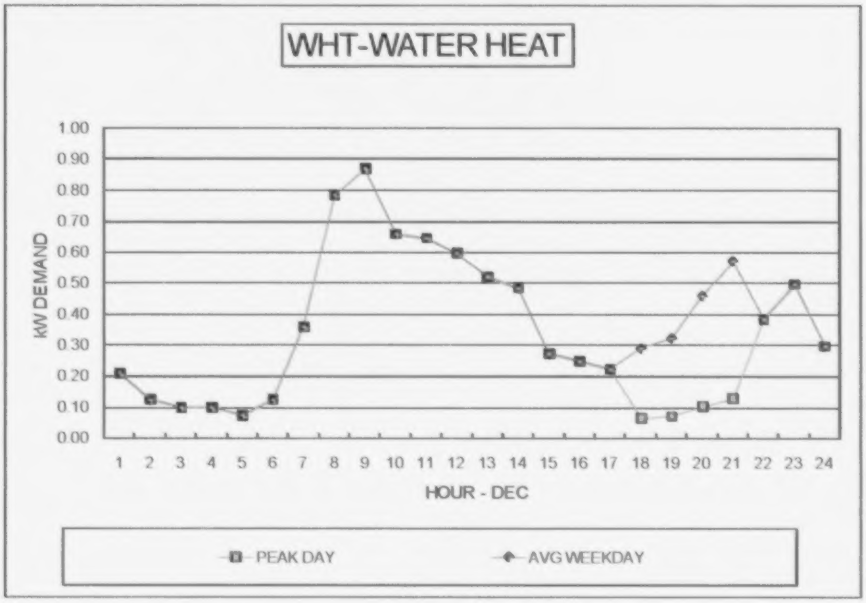
Costs

Switches cost about $100 per unit, plus $100 for installation, plus maintenance. Costs are reduced to $125 (i.e., $25 incremental installation) if the control switch can be added to an existing control system at the same time, including any remote system, which may include thermostat control, engine block heater control, lighting or other. There is no savings in installation costs for a new home.

Electric Peak Reduction

Assuming annual energy consumption per participant (with 100% electric fuel use) of 2,762 kWh, baseline electric peak period loads are estimated as 0.245 kW for the Annual Peak Hour (6 pm) and 0.273 kW for the Evening Peak (winter peak weekday 4-8 pm). Assuming 100% load control for evening peak hours, Exhibit G 1 below illustrates the baseline vs. control load profiles on the system peak day. This results in an estimated average of 0.245 kW per unit peak reduction for the Annual Peak Hour (at 6 pm) and an average of 0.273 kW per unit peak reduction for the Evening Peak (4-8 pm), assuming no overrides or switch failures. These estimates may erode over time due to a number of factors, including signal strength losses and disabling of switches (by customers and contractors). Since the water heater switch uses a one-way communications-based system, it will require support analyses including the need for signal propagation studies and periodic sampling, and re-estimation of reliability levels, accompanied by sufficient maintenance to maintain an adequate level and accurate estimate of losses. Experience in the utility industry has shown that performance could erode significantly over time if the system is not properly maintained.

Exhibit G 1 Residential Water Heater Baseline vs. Controlled Load



Other Benefits

The water heater control switch would not provide customers with any ancillary benefits and thus the only incentive for participation would be monetary in nature, likely on a per annum or per control event basis.

Useful Life

This technology has a long history, going back at least 30 years on various types of equipment, including central air conditioners, water heaters and pool pumps. For the costing analysis, a 10-year life has been assumed, although there are programs with switches in place for longer than that.

Cost-Effectiveness Summary

Based on a one-time cost of approximately $200, ongoing maintenance of 5% (about $10/yr.) and estimated annual impacts of 0.245 kW – 0.273 kW, a preliminary estimate of the CEPR is $100-$112 per kW, when applied to all potential homes, though expected to be predominantly single detached houses. As an incremental option (existing communications gateway), the installation costs would be reduced by $75 and the resulting CEPR would be $73-$81 per kW.

Barriers and Constraints

Contractors are often the cause for lack of participation or dropouts since they may incorrectly blame the switches for system performance problems, dissuading participation or resulting in removals. New tenants or their contractors may not know what the switches are and have them removed. With one-way communications, there is no way to verify whether the switch is even in place and an accurate count of actual switches in place cannot be reliably made without a systematic site verification plan.

Program Issues

Since there are no customer benefits inherent in the technology, a cash incentive would typically be expected for each season that the measure was needed, payable either by season or by event (or both). Additional work would be required to maintain, verify and evaluate the system performance to the same degree of accuracy as two-way systems due to the lack of confirmation and higher incidence of removals and failures.

Block Heater timers and storage

Engine Block Heater Load Control
Assumptions used for Analysis

Applicable Dwelling Type(s)	▪ All dwellings with individual unit control/ circuits
Applicable Equipment Type	▪ Block heaters and warmers
Vintage	▪ Existing and new
Costs	▪ $50 cost in existing and new homes (new and incremental) ▪ $25 installation cost, or $10 as an add on to an existing control system install ▪ Approximately $5/site/yr. maintenance/evaluation
Electric Peak Reduction	▪ 100% reduction in evening peaks ▪ 100% of energy reduction during curtailment is recovered
Useful Life	▪ 10 years

Description

Engine block heater timers and/or control are accomplished by the installation of a timer that could be monitored and/or controlled by the utility to ensure that it is not overridden. The critical component in this application is to defer any operation until after the 4-8 pm peak period (the Evening Peak, which includes the 6 pm Annual Peak Hour), especially in December, but including weekends as well. While timers can be used to reduce unnecessary energy consumption, reducing the heat cycle from 8-12 hours per day to the 2-3 hours per day that is required to ensure that the engines can be restored to warm enough temperatures to start, the timing of the operation is particularly key to the capacity control aspect. Ideally, operation should be staggered within local areas to prevent a local distribution peak, as well as to relieve the overall system peak associated with the 4-8 pm period for Yukon.

Applicability

Applicable dwelling types are any dwelling units with a garage or proximity of plug-in heaters to the home. This would include all but some multi-family dwellings where individual occupants do not have access to electricity for block heaters.

Costs

Switches cost about $50 per unit, plus $25 for installation, plus maintenance. Installation costs are reduced to $10 for incremental installation if the timer switch can be installed during installation of other systems. There is no savings in installation costs for a new home.

Electric Peak Reduction

Assuming annual energy consumption per participant of 258 kWh, baseline electric peak period loads are estimated as 0.173 kW for the Annual Peak Hour (6 pm) and 0.216 kW for the Evening Peak (winter peak weekday 4-8 pm). Assuming 100% load control for evening peak hours, Exhibit G 2 below illustrates the baseline vs. control load profiles on the system peak day. This results in an estimated average of 0.173 kW per unit peak reduction for the Annual Peak Hour (at 6 pm) and an average of 0.216 kW per unit peak reduction for the Evening Peak (4-8 pm), assuming no overrides or switch failures. These estimates may erode over time due to a number of factors, e.g., disabling of switches (by customers and contractors) and malfunctioning timers, so some maintenance and ongoing monitoring should be expected.

In Exhibit G 2, the red line represents the timer control option (controlled peak day) while the green line (peak day) represents the baseline. None of these load profiles assumes the use of timers used solely to reduce energy, which would not necessarily reduce evening peak demand unless specifically programmed to do so. The degree to which timers are set to defer usage and also lock out operation during 4-8 pm would be considered duplicated savings.

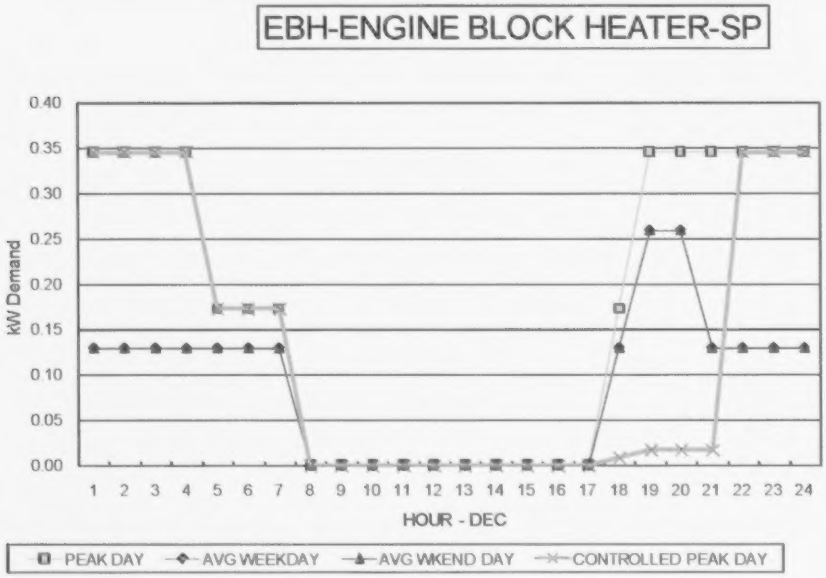
Other Benefits

The timers would also provide energy savings and, depending on any time-of-use rate in effect, could also be operated to maximize bill savings.

Useful Life

Timers are an established technology. For the costing analysis, a 10-year life has been assumed, although timers can be expected to last longer than that if maintained in clean working condition.

Exhibit G 2 Residential Block Heater Baseline vs. Controlled Load



Cost-Effectiveness Summary

Based on a one-time cost of approximately $50, ongoing maintenance of 10% (about $5/yr.) and estimated annual impacts of 0.173 kW – 0.216 kW per switch, a preliminary estimate of the CEPR is $52-$65 per kW when applied to most target sub sector homes. As an incremental option to other installations of switches, the installation costs could be reduced by $15 and the resulting CEPR would be $45-$56 per kW.

Barriers and Constraints

Contractors or residents may disconnect the timers if their schedules are disrupted, such as in power outages, depending on the nature of the switches. Some switches may not maintain the correct time without some type of battery backup. New tenants or their contractors may not know what the switches are and have them removed.

Program Issues

Without time-of-use rates, customers have no particular incentive to maintain the lock out feature or timer operation to exclude the 4-8 pm period, so some monitoring may be necessary to ensure that block heater operation avoids system peaks. Additional monitoring and sampling would be required to maintain, verify and evaluate the system performance to a sufficient degree of accuracy due to the lack of confirmation and higher incidence of removals and failures unless the system is part of an integrated home control system.

Lighting Load Control

Switch-based Lighting Load Control
Assumptions used for Analysis

Applicable Dwelling Type(s)	▪ All dwelling types
Applicable Equipment Type	▪ Non-essential lighting
Vintage	▪ Existing and new
Costs	▪ $50 incremental cost in existing and new homes ▪ Approximately $5/site/yr. maintenance/evaluation
Electric Peak Reduction	▪ 100% of non-essential lighting, assumed as 33% of baseline lighting usage (0.249 kW for the Annual Peak Hour) = 0.082 kW. ▪ No recovery energy is assumed
Useful Life	▪ 10 years

Description

In every home, there are a number of non-essential lighting and plug loads (including "phantom" loads[56]) that could be controlled for limited periods, such as during system peak critical hours, including holiday lights (depending on when the system peak occurs). Switch-based lighting load control is accomplished by the installation of a remote control switch on non-essential lighting circuits, wall switches and plug-in lamps or decorative lighting. Existing home automation systems currently utilize plug-in modules with communication via power line carrier or short-run radio signals. These systems can also interface with PCs and through telephone interfaces so that remote control can be accomplished as well. In terms of technical capability, the improvements to these existing systems that will facilitate their use in utility electric peak load control would require some reduced cost and more standardized and reliable remote interfaces. Current home automation systems do not typically have the capability for remote programming for on-demand control use, so this capability would need to be developed. Most likely, this would be achieved as part of an add-on wireless communications control switch linked to the outside through a remote load control system already in place to maximize or even enable cost effectiveness. What is required is a "gateway" via broadband (e.g., broadband over power lines) or through the meter (these types of systems are all now being tested in the field) that would accept outside signals (such as from the utility) and convert them to short-run wireless (or wired) signals that would trigger switches placed on selected lights and appliances.

This section describes the lighting applications only, in order to determine effect on lighting load profiles. The next section addresses aspects of non-lighting loads, although lighting and non-lighting plug loads are not expected to require separate systems, but rather a single gateway that controls switches for any plug load or, for lighting, wall switch. This technology would be applicable for single-family homes and row houses, as well as for apartments, which could make effective use of total building communications through building wiring or a building wi-fi system, as is common for electrical sub metering applications today.

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[56] Phantom loads are typically defined as standby loads on appliances, set-top boxes, televisions, electronics-charging units and other devices intended to facilitate instant-on capability or charging units/transformers that use electricity even when not being actively used for their intended purpose.

Applicability

This measure is applicable to all residential dwelling types, but would likely be most applicable to single-family homes with outdoor lighting.

Costs

Gateway systems are estimated at $100-$300 per site installed, although they would be expected to serve multiple purposes. For example, a programmable communicating thermostat or electric meter already in the house for other applications could include a relay board that would relay signals from a remote host over broadband or other remote communications to individual household devices for only this purpose. Switches are assumed to cost about $5 per unit, which could control multiple lights and plug loads. There is no savings assumed for installation costs for a new home.

Electric Peak Reduction

Based on annual lighting loads per household of 1,029 kWh, the average lighting loads per household during the 6 pm Annual Peak Hour would be 0.249 kW, or for the 4-8 pm Evening Peak approximately 0.276 kW. Assuming 33% of the lighting could be reduced with two switches, this would result in a 0.082 - 0.091 kW per household electric peak load reduction, or just under 100 Watts. In Exhibit G 3, the red line represents the timer control option (controlled peak day) during the 4-8 pm period, while the green line (peak day) represents the baseline.

Other Benefits

The gateway systems and switches would provide customers with many ancillary benefits, such as remote shut off of lights and appliances for security, convenience and energy saving, although no energy savings has been assumed for this analysis.

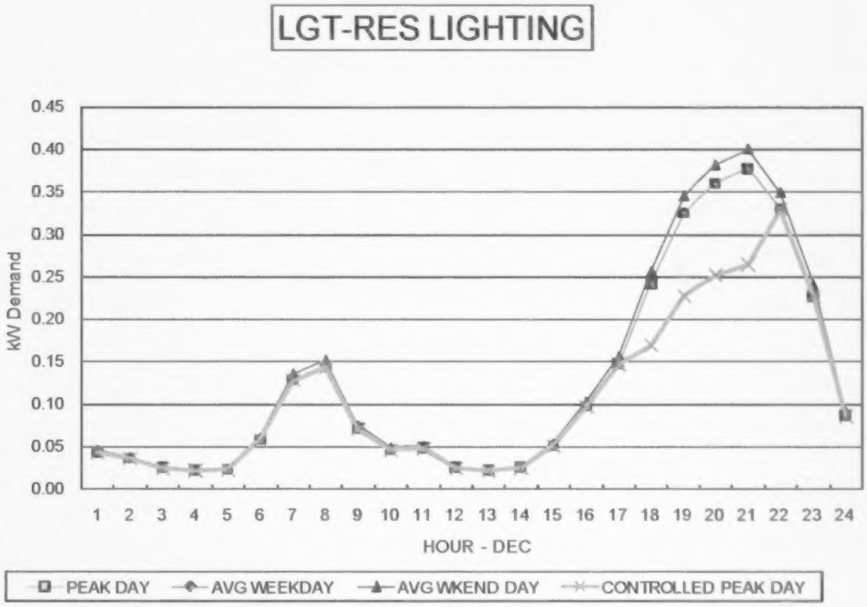
Useful Life

This technology has a fairly long history, going back at least 20 years for various protocols of home automation devices, including X-10 protocol units, which have been available through electronics stores under various brand names. For the costing analysis, a 10-year life has been assumed, although the units typically last 10-15 years.

Cost-Effectiveness Summary

There are two scenarios analyzed. Based on the inclusion of a modest ($100) gateway system installation and two switches (at $10 each), installation cost of approximately $50, ongoing maintenance/support of 10% (about $10/yr.) and estimated annual impacts of 0.082 kW – 0.091 kW, the estimated CEPR is $256-$285 per kW/yr. For practical and economic purposes, this type of system would not likely be used in stand-alone cases, so the second scenario assumes that the gateway is an existing device (e.g., meter, communicating thermostat, remote water heater control system) with no additional capital cost and only some costs ($20) for installation of switches (plug switches can be easily installed by the customer while wall switches require some experience but no electrical license), and some annual support ($5). Under this scenario, the lifecycle CEPR is $73-$81 per kW/yr.

Exhibit G 3 Residential Lighting Baseline vs. 30% Controlled Load



Barriers and Constraints

The technology for this application exists but is not quite ready for general use and would be greatly enhanced by the introduction of gateways that are only now being pilot tested. In addition, without some type of time-based rate, there would be little incentive for customers to purchase these devices, even as timers, without cash incentives.

Program Issues

In the short term, the utility could work with home electronics stores to encourage use of home automation and couple that with appeals to program the devices to shut off non-essential lighting during the defined peak period of 4-8 pm, especially holiday lighting during system critical periods. This would be facilitated by adoption of time-of-use rates that would be consistent with the peak periods, with critical peak pricing periods on a handful of system peak days providing the additional incentive for customers to utilize their systems during system peak critical periods. The switches can be overridden easily so programming them as a default to shut off certain lights for the peak winter months with the option to turn them back on if needed would be feasible.

Multiple (Whole House and Miscellaneous Plug Loads)

See the discussion on lighting (above) for description, applicability, and costs, which are the same.

Electric Peak Reduction

Based on annual plug loads and miscellaneous electronics loads per household for single-family detached houses, there are numerous devices to which this measure could be applied. Principal among these would be instant-on televisions, set-top boxes and electronic device chargers (many of which could be "ganged" on one power strip with a single switch). For the purposes of this analysis, it is assumed that 60 - 82 Watts of devices could be controlled, which represents 50% of the current peak contribution for computers, TVs, Set-top boxes, miscellaneous electronics and small appliances. The table below lists the best candidates, based on a study by LBNL,[57] as well as other sources and project team experience.

Appliance	Range of Power Consumption (Watts)
Compact Audio Components	1 – 15 W
Personal Computer	2 – 5 W
Ink Jet or Laser Printer	4 – 6 W
Large-screen television	5 – 22 W
Phone or answering machine	2 – 5 W
Set-top Box	5 – 25 W
DVD/VCR	4 – 22 W
Home Theatre[58]	12 – 56 W

Cost-Effectiveness Summary

Based on the 100% incremental scenario, whereby three switches ($15) and $5 for incremental installation costs, $2.50/year for maintenance, and estimated annual impacts of 60 to 82 Watts on demand, encompassing a mix of the above devices being controlled, the estimated CEPR is $168 - $229 per kW/yr. For practical purposes, this type of system would not be used in stand-alone cases, only as an increment to an existing gateway system with lighting switches already in place. Adding stand-alone gateway installation ($100 initial cost) would result in an estimated CEPR of $47 - $64 per kW/yr.

Swimming Pools and Spa Units

Description

Switch-based swimming pool and spa pump load control is accomplished by the installation of a remote control switch on either the pump itself or on the circuits controlling the pump. In older systems, this type of control has been accomplished via radio frequency (RF) control, which allows remote shut off of the pump under specific capacity-constrained conditions during a limited number of pre-specified hours during winter peak months. In some systems, broadband-/ wi-fi-based communications can also be used. An even more economic solution is to piggyback off of an already existing communications system. For example, if space or water heat control already exists, pump control can be added via a hard-wired or wireless connection. This can reduce the total cost of the pump control by up to 50%.

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[57] Stand-by Power http:/standby.lbl.gov – Lawrence Berkeley National Labs.

[58] Standby Trends in Australia and Mandatory Standby Power Proposals, C. Edlington et al; 2006 ACEEE Summer Study on Energy Efficiency in Buildings.

Depending upon the length of the control, pumps can be shut off for the entire control period. Cycling is not recommended as it can damage the equipment. Pool and spa pump control is commercially available and implemented in hundreds of thousands of sites in the U.S., thus demonstrating the viability of the technology, success of the programs, customer acceptance and utility satisfaction.

Switch-based Swimming Pool Pump and Spa Pump Load Control
Assumptions used for Analysis

Applicable Dwelling Type(s)	▪ Single-family detached and attached, row houses, multi-family – all with individual dwelling unit control/circuits
Applicable Equipment Type	▪ Swimming pool and spa pump at least ¾ HP
Vintage	▪ Existing and new
Costs	▪ $265 incremental cost in existing and new homes ▪ $140 incremental cost as an add on to an existing control system ▪ Approximately $12/site/yr. maintenance/evaluation
Electric Peak Reduction	▪ Assume 50% of baseline loads, no energy recovery
Useful Life	▪ 10 years (comparable to lighting controls)

Applicability

Applicable dwelling types are any dwelling unit with a swimming pool or spa pumps at least ¾ HP in size. The minimum HP of the pump is necessary to ensure that enough load savings can be obtained. Swimming pools or spas that have automatic vacuum systems that run off the pump are not applicable for this control since turning off the pump while the automatic vacuum is operating can damage the vacuum.

Costs

Switches cost about $115 per unit, plus $150 for installation, plus maintenance. Costs are reduced to $125 if the control can be added to an existing control system. There is no savings in installation costs for a new home.

Electric Peak Reduction

Based on annual consumption of pools and spas of 8,164 kWh per end use for single-family detached / duplex, the predominant target for this measure, the peak period average demands are as follows:

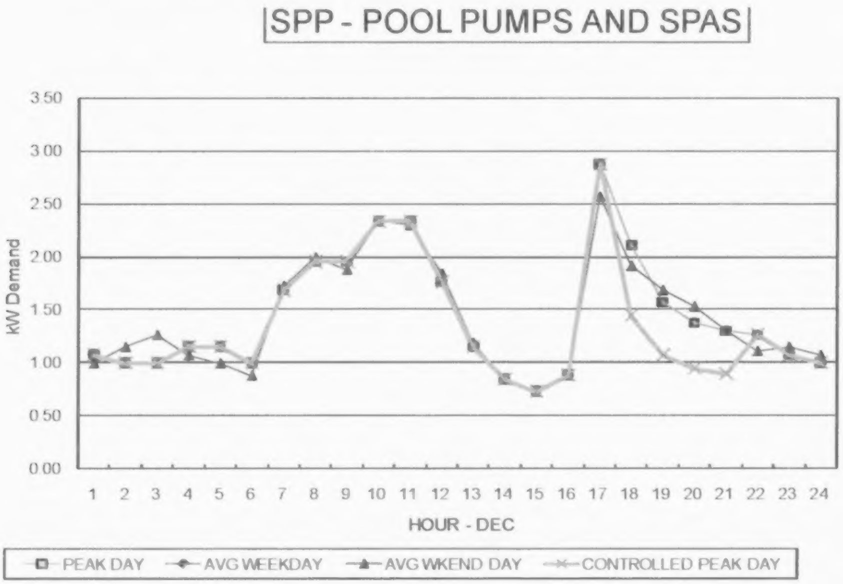
▪ Annual Peak Hour (peak day 6 pm)	1.25 kW
▪ Evening Peak (peak day 4-8 pm)	1.17 kW

Assuming 50% reduction, electric peak impacts on a household basis would thus average about 0.587 – 0.624 kW per customer for the Evening Peak, equivalent to a ¾ HP motor draw. These estimates may erode over time due to a number of factors, including signal strength losses and disabling of switches (by customers and contractors). Since the pump switch uses a one-way communications-based system, it will require support analyses including the need for signal propagation studies and periodic sampling and re-estimation of reliability levels, accompanied by sufficient maintenance, to maintain an adequate level and accurate estimate of losses.

Experience in the utility industry has shown that performance could erode significantly over time if the system is not properly maintained.

Exhibit G 4 represents the average load profile impacts, assuming a net 0.6 kW per unit reduction for pool pumps and spas. The red line represents the controlled load, as compared the peak day load in green.

Exhibit G 4 Swimming Pools and Spas Baseline vs. Controlled Load



Other Benefits

The pump control switch would not provide customers with any ancillary benefits and thus the only incentive for participation would be monetary in nature, unless time-of-use or critical peak pricing was instituted.

Useful Life

This technology has a long history, going back at least 30 years on various types of equipment, including central air conditioners, water heaters and pool pumps. For the costing analysis, a 10-year life has been assumed, comparable to lighting controls although there are programs with switches in place for longer than that.

Cost-Effectiveness Summary

Based on a one-time cost of approximately $265, ongoing maintenance of 10% (about $25/yr.) and estimated annual impacts of 0.587 – 0.624 kW, an estimate of the CEPR is $72 - $77 per kW/yr. For incremental installations, costing only $125, the CEPR is approximately $34 - $36 per kW/yr.

Barriers and Constraints

Contractors are often the cause for lack of participation or dropouts, since they may incorrectly blame the switches for system performance problems, dissuading participation or resulting in removals. New tenants or their contractors may not know what the switches are and have them removed. With one-way communications, there is no way to verify whether the switch is even in place and an accurate count of actual switches in place cannot be reliably made without a systematic site verification plan.

Program Issues

Since there are no customer benefits inherent in the technology, a cash incentive would typically be expected for each season that the measure was needed, payable either by season or by event (or both). Additional work would be required to maintain, verify and evaluate the system performance to the same degree of accuracy as two-way thermostat systems due to the lack of confirmation and higher incidence of removals and failures. The program would need to ensure that customers who shut down their units during the winter are not included, which may be problematic without having two-way communications, or some type of inexpensive logger could be used, which would add to the maintenance costs.

Electric Thermal Storage (ETS) Central Units

Description

Electric thermal storage (ETS) is a technology that has been widely used in Europe and selectively used in North America for more than 40 years. The basic premise of the systems is to convert electricity into heat and store it in specially designed high-density ceramic bricks, capable of holding heat up to 1,650°C. Combined with a utility off-peak rate, operation in charging mode during low-cost off-peak hours can provide heat all day, if properly sized, by thermostat-controlled release of heat from the bricks through either forced air or hydronic systems. Units come in various sizes, from whole-house units to individual room units. Control systems to ensure proper heat distribution are typically included and systems can be retrofitted or installed in new construction applications. The principal manufacturer in North America is Steffes Corp.,[59] and marketing is principally accomplished through electric co-ops, as well as many northern U.S. and Canadian utilities, including Nova Scotia Power and Hydro-Quebec, where a sufficient differential between peak and off-peak prices during winter months makes it economical for residents. Many winter-peaking generation/Transmission & Distribution co-ops market the units in order to minimize their capacity requirements during peak winter times.

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[59] http://www.steffes.com

Electric Thermal Storage (ETS) Central Units
Assumptions used for Analysis

Applicable Dwelling Type(s)	▪ Electrically heated single family, row houses and apartments – requires off-peak rate structure
Applicable Equipment Type	▪ Central furnace units using forced air or hydronic systems for central furnace ETS units
Vintage	▪ Existing and new
Costs	▪ Assuming 15-hour operation (9-hour overnight charge time): ▪ $4,000-$4,500 for central ETS units vs. $1,500 for standard heating system (50,000 BTU); ▪ Assume $500 incremental installation costs; approximately $100/site/yr. incremental maintenance
Electric Peak Reduction	▪ Assume 95% of current full electric loads (assuming 5% override), operating 100% off-peak otherwise, with only residual fan (same as baseline) during 15 daytime hours. Estimated 4.65 kW peak ▪ Approximately 5% increase in space heating energy for losses
Useful Life	▪ 18 years (comparable to heat pump) for central

Applicability

With the various size units available, ETS can be installed in any size dwelling, either as a whole-house system or in selected (or all) rooms. It can therefore replace central furnace hot air or boiler/hydronic systems, or even baseboard systems. Often, a separate meter is used to measure just the central heating systems to best take advantage of the off-peak rate. Systems must be sized based on the time-of-use rate, with charging periods designed to virtually eliminate any operation during peak periods. For Yukon, a 15-hour peak rate period (7 am – 10 pm) and a nine-hour off-peak rate (10 pm – 7 am) would be used by the utility.

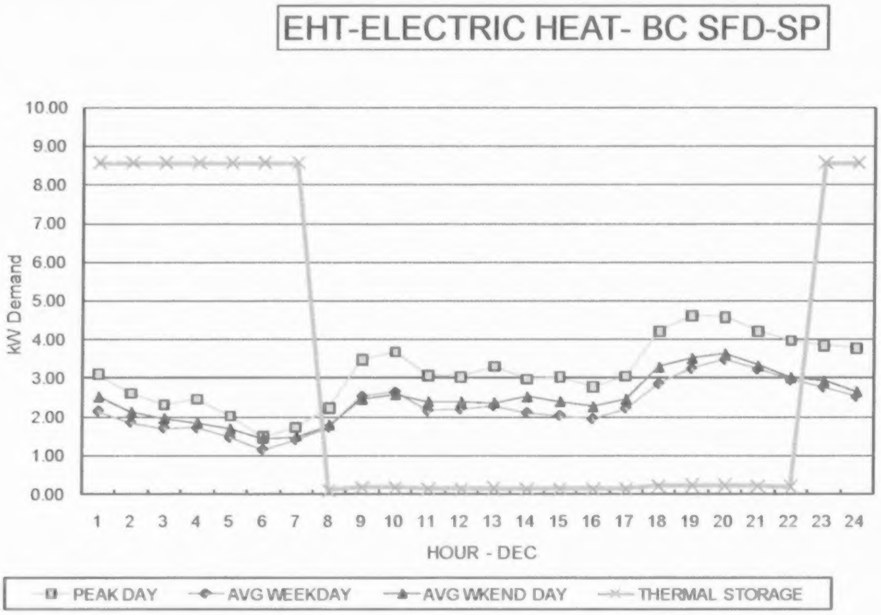
Costs

Initial costs for ETS systems are significantly higher than standard heating systems. For the economics to work for the customer, the rate differential must be significant, at least two-three to one for peak to off-peak. Initial costs are roughly proportional to the unit sizing, with an ETS system requiring two to three times the size of a standard system, and somewhat higher installation and maintenance costs. In addition, additional control equipment and sometimes wiring upgrades are necessary, as well as placement in the home (requires sufficient support for additional weight), making the specification of a system critical in terms of applicability. In general, larger homes work best. For the purpose of this study, preliminary costs have been developed based on a literature search and an interview with a representative of Steffes Corp.

Electric Peak Reduction

Electric peak load reduction would be theoretically 100% of the peak heating requirements of a standard electric space heater. Off-peak loads would be over twice the levels so it would be critical to size the systems properly for the expected charging period. For example, for a single detached house with 10,722 annual kWh for space heating, average 7 am – 10 pm loads would be about 3.5 kW, peaking at about 4.6 kW. For the costing analysis, it is assumed that 5% of the usage would still be on peak to account for minimal overrides or where units do not provide all heating requirements through off-peak charging (even though theoretically designed to do so). For a central ETS unit, the comparable overnight (charging) on a peak day would be about 8.6 kW, as illustrated in Exhibit G 5. Peak load reduction would therefore be about 4.41 kW at the hour ending 7 pm system peak and average 4.21 kW during the 4-8 pm peak period.

Exhibit G 5 Electric Thermal Storage Heating – Central Units



Other Benefits

None.

Useful Life

This technology has a long history in Europe and the bricks are virtually indestructible, so the useful life is considered the same as comparable central or room heating systems (15-18 years). Electronic control systems are required, which involve some maintenance.

Cost-Effectiveness Summary

For central systems, analysis is based on a one-time incremental cost of approximately $3,800 for the unit plus $500 installation, plus $150 for metering/control equipment and $100 annual maintenance. Estimated annual impacts of about 3.6 kW were used, based on 95% of Peak Periods 1 and 2 loads. Under those assumptions, the estimate of the CEPR is $99-$101 per kW/yr.

Barriers and Constraints

The prerequisite for an off-peak rate with significant differential is a major consideration, which would require additional metering and infrastructure (priced at $150 per site). Numerous logistical and wiring issues would also need to be addressed, which would require significantly more effort in pre-inspection and which would only be feasible for the utility's assistance if the program was large enough to warrant maintaining the staff expertise required. Space requirements and sufficient weight-bearing floors for installation of the units, which are much heavier than standard heating equipment, would be potential constraining factors to feasible installations.

Program Issues

While many co-ops and several major Canadian utilities have programs for this application, and could be consulted to assist in designing the program and identifying barriers experienced in real implementation not just pilot programs, the programming infrastructure required would involve a significant commitment. In addition, the off-peak rate would need to be in place and tested, which would require some level of regulatory approval.

Electric Thermal Storage (ETS) Room Units

Description

See the description for central units above. Room units are sized and configured to replace baseboard systems, typically as supplemental heating or for rooms not otherwise heated.

Electric Thermal Storage (ETS) Room Units
Assumptions used for Analysis

Applicable Dwelling Type(s)	▪ All dwelling types not already fully electrically heated – requires off-peak rate structure
Applicable Equipment Type	▪ Baseboard systems compatible with replacement by stand-alone room unit ETS systems
Vintage	▪ Existing and new
Costs	▪ Assuming 15-hour operation (9-hour overnight charge time): ▪ $1,200-$1,600 for room ETS units, vs. $400 for standard room baseboard system ▪ Assume $200 incremental installation costs; approximately $50/site/yr. incremental maintenance
Electric Peak Reduction	▪ Assume 95% of current full electric loads (assuming 5% override), operating 100% off-peak otherwise, with only residual fan (same as baseline) during 15 daytime hours. Estimated 35% of annual kWh attributable to target room ▪ Approximately 5% increase in space heating energy for losses
Useful Life	▪ 15 years (comparable to heat pump)

Applicability

With the various size units available, ETS can be installed in any room to replace, or supplement, electric baseboard systems. Often, a separate meter is used to measure just the central heating systems to best take advantage of the off-peak rate but a separate meter would not be viable for room units. Systems would be configured to take advantage of rates, ideally a time-of-use rate, with charging periods designed to virtually eliminate any operation during peak periods. For Yukon, a 15-hour peak rate period (7 am – 10 pm) and nine-hour off-peak rate (10 pm – 7 am) would be used by the utility.

Costs

Initial costs for ETS systems are significantly higher than standard heating systems. For the economics to work for the customer, the rate differential must be significant, at least two-three to one for peak to off-peak. Initial costs are roughly proportional to the unit sizing, with an ETS system requiring two to three times the size of a standard system, and somewhat higher installation and maintenance costs. In addition, additional control equipment and sometimes wiring upgrades are necessary, as well as placement in the home (requires sufficient support for additional weight), making the specification of a system critical in terms of applicability. In general, larger homes work best. For the purpose of this study, preliminary costs have been developed based on a literature search and an interview with a representative of Steffes Corp.

Electric Peak Reduction

Electric peak load reduction would be theoretically 100% of the peak heating requirements of a standard electric space heater for the applicable room. Off-peak loads would be over twice the levels so it would be critical to size the systems properly for the expected charging period. For example, for a large room with 3,750 annual kWh requirements for space heating, average 7 am – 10 pm loads would be about 0.85 kW, peaking at about 1.12 kW. For the costing analysis, it is assumed that 5% of the usage would still be on peak to account for minimal overrides or where units do not provide all heating requirements through off-peak charging (even though theoretically designed to do so). For a room ETS unit, the comparable overnight (charging) on a peak day would be about 2.06 kW, as illustrated in Exhibit G 6. Peak load reduction would therefore be about 1.25 kW at the hour ending 6 pm system peak.

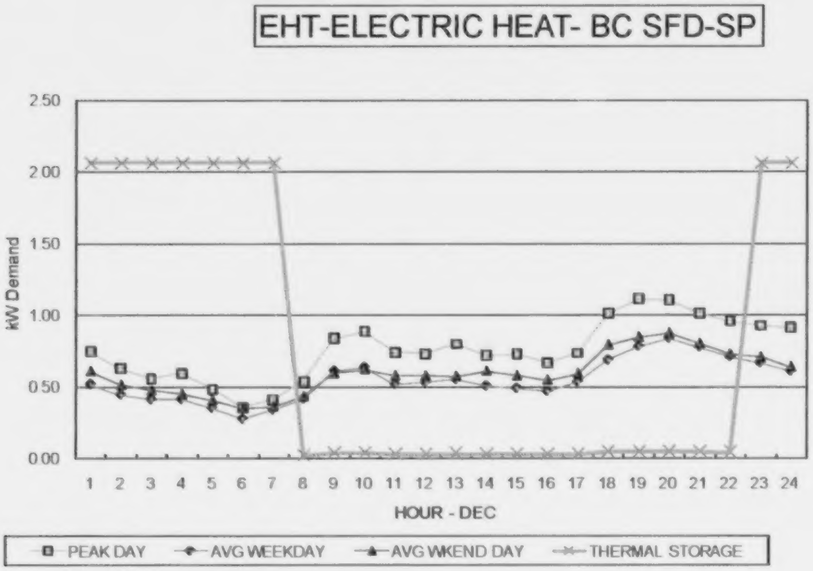
Other Benefits

None.

Useful Life

This technology has a long history in Europe and the bricks are virtually indestructible, so the useful life is considered the same as comparable room heating systems (15 years). Electronic control systems are required, which involve some maintenance.

Exhibit G 6 Electric Thermal Storage Heating – Room Unit



Cost-Effectiveness Summary

For central systems, analysis is based on a one-time incremental cost of approximately $1,000 for the unit plus $150 installation, plus $50 annual maintenance. Estimated annual impacts of 1.24–1.27 kW were used, based on 95% of Peak Periods 1 and 2 loads. Under those assumptions, a preliminary estimate of the CEPR is $85-$87 per kW/yr.

Barriers and Constraints

The existence of an off-peak rate with significant differential is a major consideration, although additional metering and infrastructure (priced at $150 per site) would not be justified solely for this purpose. Numerous logistical and wiring issues would also need to be addressed. Space requirements and sufficient weight-bearing floors for installation of the units, which are much heavier than standard heating equipment, would be potential constraining factors to feasible installations.

Program Issues

While many co-ops and several major Canadian utilities have programs for this application, which could be consulted to assist in designing the program and identifying barriers experienced in real implementation (not just pilot programs), the programming infrastructure required would involve a significant commitment.

Measure Lifecycle Costing Worksheets

The following worksheets detail the calculation of CEPR[60] for each of the electric peak measures listed.

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[60] The lifecycle measure cost is the annualized capital, installation and operating cost of the measure over its useful life.

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Water Heating

1 **One-time Costs - Retrofit**			2 **Recurring Costs ($/yr.)**		
	Capital/Device	$100.00		Maintenance	$10.00
	Installation	$100.00		Support	$0.00
	Other	$0.00		Other	$0.00
	Total	$200.00		Total	$10.00
3 **Net present Value Cost (1)**		$273.79			
		Low	High		
4 **Peak Reduction (kw/yr.)**		0.245	0.273		
5 **LIFECYCLE Peak reduction**		2.45	2.73		
				11,326	count
6 **Cost of Electric Peak Reduction (CEPR)**				2.8	MW to
	(Rounded to $)	**$112.00**	**$100.00**	3.1	MW
		Average	$106.00	2.9	Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Water Heating (incremental)

1 **One-time Costs - Retrofit**			2 **Recurring Costs ($/yr.)**		
	Capital/Device	$100.00		Maintenance	$10.00
	Installation	$25.00		Support	$0.00
	Other	$0.00		Other	$0.00
	Total	$125.00		Total	$10.00
3 **Net present Value Cost (1)**		$198.79			
		Low	High		
4 **Peak Reduction (kw/yr.)**		0.245	0.273		
5 **LIFECYCLE Peak reduction**		2.45	2.73		
				11,326	count
6 **Cost of Electric Peak Reduction (CEPR)**				2.8	MW to
	(Rounded to $)	**$81.00**	**$73.00**	3.1	MW
		Average	$77.00	2.9	Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

Electric Thermal Storage - Central Heating System

1	**One-time Costs**		2	**Recurring Costs ($/yr.)**	
	Capital/Device	$3,800.00		Maintenance	$100.00
	Installation	$500.00		Support	$0.00
	Other (Meter)	$150.00		Other	$0.00
	Total	$4,450.00		Total	$100.00
3	**Net present Value Cost (1)**	$5,399			
		Low	High		
4	**Peak Reduction (kw/yr.)**	3.555	3.640	(95% of Peak period 2)	
5	**LIFECYCLE Peak reduction**	53.33	54.61		
				1,916	count
6	**Cost of Electric Peak Reduction (CEPR)**			6.81	MW to
	(Rounded to $)	**$101**	**$99**	6.98	MW
		Average	$100.00	6.90	Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	15			

LIFECYCLE COSTING WORKSHEET

Electric Thermal Storage - 1 Room Unit Supplemental Heating System

1	**One-time Costs**		2	**Recurring Costs ($/yr.)**	
	Capital/Device	$1,000.00		Maintenance	$50.00
	Installation	$150.00		Support	$0.00
	Other (Meter)	$0.00		Other	$0.00
	Total	$1,150.00		Total	$50.00
3	**Net present Value Cost (1)**	$1,624			
		Low	High		
4	**Peak Reduction (kw/yr.)**	1.244	1.274	(95% of Peak period 1,2)	
5	**LIFECYCLE Peak reduction**	18.67	19.11		
				1,384	count
6	**Cost of Electric Peak Reduction (CEPR)**			1.72	MW to
	(Rounded to $)	**$87**	**$85**	1.76	MW
		Average	$86.00	1.74	Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	15			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Engine Block Heater

1	**One-time Costs - Retrofit**		2 **Recurring Costs ($/yr.)**		
	Capital/Device	$50.00		Maintenance	$5.00
	Installation	$25.00		Support	$0.00
	Other	$0.00		Other	$0.00
	Total	$75.00		Total	$5.00
3	**Net present Value Cost (1)**	$111.89			
		Low	High		
4	**Peak Reduction (kw/yr.)**	0.173	0.216		
5	**LIFECYCLE Peak reduction**	1.73	2.16		
				10,172	count
6	**Cost of Electric Peak Reduction (CEPR)**			1.8	MW to
	(Rounded to $)	**$65.00**	**$52.00**	2.2	MW
		Average	$58.50	2.0	Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Engine Block Heater (incremental)

1	**One-time Costs - Retrofit**		2 **Recurring Costs ($/yr.)**		
	Capital/Device	$50.00		Maintenance	$5.00
	Installation	$10.00		Support	$0.00
	Other	$0.00		Other	$0.00
	Total	$60.00		Total	$5.00
3	**Net present Value Cost (1)**	$96.89			
		Low	High		
4	**Peak Reduction (kw/yr.)**	0.173	0.216		
5	**LIFECYCLE Peak reduction**	1.73	2.16		
				10,172	count
6	**Cost of Electric Peak Reduction (CEPR)**			1.8	MW to
	(Rounded to $)	**$56.00**	**$45.00**	2.2	MW
		Average	$50.50	2.0	Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Lighting (stand-alone)

1 **One-time Costs - Retrofit**			2 **Recurring Costs ($/yr.)**		
	Capital/Device	$100.00		Maintenance	$5.00
	Installation	$50.00		Support	$5.00
	Switches	$10.00		Other	$0.00
	Total	$160.00		Total	$10.00
3 **Net present Value Cost (1)**		$233.79			
		Low	High		
4 **Peak Reduction (kw/yr.)**		0.082	0.091		
5 **LIFECYCLE Peak reduction**		0.82	0.91		
				14,622	count
6 **Cost of Electric Peak Reduction (CEPR)**				1.2	MW to
	(Rounded to $)	**$285.00**	**$256.00**	1.3	MW
		Average	$270.50	1.3	Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Lighting (incremental)

1 **One-time Costs - Retrofit**			2 **Recurring Costs ($/yr.)**		
	Capital/Device	$0.00		Maintenance	$0.00
	Installation	$20.00		Support	$5.00
	Switches	$10.00		Other	$0.00
	Total	$30.00		Total	$5.00
3 **Net present Value Cost (1)**		$66.89			
		Low	High		
4 **Peak Reduction (kw/yr.)**		0.082	0.091		
5 **LIFECYCLE Peak reduction**		0.82	0.91		
				14,622	count
6 **Cost of Electric Peak Reduction (CEPR)**				1.2	MW to
	(Rounded to $)	**$81.00**	**$73.00**	1.3	MW
		Average	$77.00	1.3	Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Plug Loads

1 **One-time Costs - Retrofit**			2 **Recurring Costs ($/yr.)**		
	Capital/Device	$100.00		Maintenance	$2.50
	Installation	$5.00		Support	$0.00
	Switches	$15.00		Other	$0.00
	Total	$120.00		Total	$2.50
3 **Net present Value Cost (1)**		$138.45			
		Low	High		
4 **Peak Reduction (kw/yr.)**		0.060	0.082		
5 **LIFECYCLE Peak reduction**		0.60	0.82		
				14,622	count
6 **Cost of Electric Peak Reduction (CEPR)**				0.9	MW to
	(Rounded to $)	**$229.00**	**$168.00**	1.2	MW
		Average	$198.50	1.0	Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Plug Loads (incremental)

1 **One-time Costs - Retrofit**			2 **Recurring Costs ($/yr.)**		
	Capital/Device	$0.00		Maintenance	$2.50
	Installation	$5.00		Support	$0.00
	Switches	$15.00		Other	$0.00
	Total	$20.00		Total	$2.50
3 **Net present Value Cost (1)**		$38.45			
		Low	High		
4 **Peak Reduction (kw/yr.)**		0.060	0.082		
5 **LIFECYCLE Peak reduction**		0.60	0.82		
				14,622	count
6 **Cost of Electric Peak Reduction (CEPR)**				0.9	MW to
	(Rounded to $)	**$64.00**	**$47.00**	1.2	MW
		Average	$55.50	1.0	Avg MW
	(1) Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Pools/Spas

1 **One-time Costs - (stand-alone)**			2 **Recurring Costs ($/yr.)**	
Capital/Device	$115.00		Maintenance	$25.00
Installation	$150.00		Support	$0.00
Switches	$0.00		Other *	$0.00
Total	$265.00		Total	$25.00
3 **Net present Value Cost (1)**	$449.47		* Rate Discount or Incentive	
	Low	High		
4 **Peak Reduction (kw/yr.)**	0.587	0.624	(50% applicable)	
5 **LIFECYCLE Peak reduction**	5.87	6.24		
			1,120	count
6 **Cost of Electric Peak Reduction (CEPR)**			0.7	MW to
(Rounded to $)	**$77.00**	**$72.00**	0.7	MW
	Average	$74.50	0.7	Avg MW
(1) Discount Rate/yr.	7.5%			
Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Pools/Spas

1 **One-time Costs - incremental**			2 **Recurring Costs ($/yr.)**	
Capital/Device	$75.00		Maintenance	$12.00
Installation	$50.00		Support	$0.00
Switches	$0.00		Other *	$0.00
Total	$125.00		Total	$12.00
3 **Net present Value Cost (1)**	$213.55		* Rate Discount or Incentive	
	Low	High		
4 **Peak Reduction (kw/yr.)**	0.587	0.624	(50% applicable)	
5 **LIFECYCLE Peak reduction**	5.87	6.24		
			1,120	count
6 **Cost of Electric Peak Reduction (CEPR)**			0.7	MW to
(Rounded to $)	**$36.00**	**$34.00**	0.7	MW
	Average	$35.00	0.7	Avg MW
(1) Discount Rate/yr.	7.5%			
Device Lifetime (yr.s)	10			

Worksheets For Calculating Counts By End Use For Per-Unit Cost Calculations And Supply Curve Development

One-Way Switch - Water Heating

Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	
1980 & newer non-electrically heated single detached homes	4419	100%	79%	3,491	
Pre-1980 non-electrically heated single detached homes	3741	100%	79%	2,955	
1980 & newer electrically heated single detached homes	672	100%	100%	672	
Pre-1980 electrically heated single detached homes	570	100%	100%	570	
Total SDH					
1980 & newer non-electrically heated attached/row housing	586	100%	79%	463	
Pre-1980 non-electrically heated attached/row housing	495	100%	79%	391	
1980 & newer electrically heated attached/row housing	89	100%	100%	89	
Pre-1980 electrically heated attached/row housing	76	100%	100%	76	
Total Attached					
Non-electrically heated apartment units	1268	80%	100%	1,014	
Non-electrically heated apartment common areas	72	20%	0%	0	
Electrically heated apartment units	198	100%	100%	198	
Electrically heated apartment common areas	11	0%	100%	0	
Total Apartment					
Non-electrically heated mobile/other	884	100%	79%	698	
Electrically heated mobile/other	129	100%	100%	129	
Total Mobile					
Small diesel grid housing	266	100%	83%	221	
Seasonal housing	862	50%	83%	358	
Residential garages	284	0%	100%	0	
Sentinel Lighting	947	0%	0%	0	
	15,569				
	Annual kWh	2,762		11,326	72.7%

	Electric Thermal Storage - Central Heating System				Central Unit	Central Unit	Room Unit	Room Unit		
Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	Applicability	Count	Applicability	Count		
1980 & newer non-electrically heated single detached homes	4419	100%	5%	221	100%	221	100%	221	628	12,560
Pre-1980 non-electrically heated single detached homes	3741	100%	5%	187	100%	187	0%	0	879	17,580
1980 & newer electrically heated single detached homes	672	100%	89%	598	100%	598	0%	0	7401	8,316
Pre-1980 electrically heated single detached homes	570	100%	89%	507	100%	507	100%	507	9105	10,230
Total SDH									SDH avg	10,722
1980 & newer non-electrically heated attached/row housing	586	100%	5%	29	100%	29	100%	29		
Pre-1980 non-electrically heated attached/row housing	495	100%	5%	25	100%	25	100%	25		
1980 & newer electrically heated attached/row housing	89	100%	89%	79	100%	79	100%	79		
Pre-1980 electrically heated attached/row housing	76	100%	89%	68	100%	68	100%	68		
Total Attached										
Non-electrically heated apartment units	1268	100%	5%	63	0%	0	100%	63		
Non-electrically heated apartment common areas	72	100%	5%	4	100%	4	100%	4		
Electrically heated apartment units	198	100%	95%	188	100%	188	100%	188		
Electrically heated apartment common areas	11	100%	95%	10	100%	10	100%	10		
Total Apartment										
Non-electrically heated mobile/other	884	100%	5%	44	0%	0	100%	44		
Electrically heated mobile/other	129	100%	89%	115	0%	0	100%	115		
Total Mobile										
Small diesel grid housing	266	100%	2%	5	0%	0	100%	5		
Seasonal housing	862	50%	5%	22	0%	0	50%	11		
Residential garages	284	100%	5%	14	0%	0	100%	14		
Sentinel Lighting	947	0%	0%	0	0%	0	0%	0		
	15,569									
Single Family for Central	Annual kWh	10,722		2,180	14.0%	1,916	12.3%	1,384	8.9%	

One-Way Switch - Engine Block Heater

Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	
1980 & newer non-electrically heated single detached homes	4419	90%	100%	3,977	
Pre-1980 non-electrically heated single detached homes	3741	82%	100%	3,068	
1980 & newer electrically heated single detached homes	672	82%	100%	551	
Pre-1980 electrically heated single detached homes	570	75%	100%	428	
Total SDH					
1980 & newer non-electrically heated attached/row housing	586	86%	100%	504	
Pre-1980 non-electrically heated attached/row housing	495	76%	100%	376	
1980 & newer electrically heated attached/row housing	89	78%	100%	69	
Pre-1980 electrically heated attached/row housing	76	69%	100%	52	
Total Attached					
Non-electrically heated apartment units	1268	0%	100%	0	
Non-electrically heated apartment common areas	72	67%	100%	48	
Electrically heated apartment units	198	0%	100%	0	
Electrically heated apartment common areas	11	67%	100%	7	
Total Apartment					
Non-electrically heated mobile/other	884	67%	100%	592	
Electrically heated mobile/other	129	67%	100%	86	
Total Mobile					
Small diesel grid housing	266	75%	100%	200	
Seasonal housing	862	0%	100%	0	
Residential garages	284	75%	100%	213	
Sentinel Lighting	947	0%	100%	0	
	15,569				
	Annual kWh	258		10,172	65.3%

One-Way Switch - Lighting (stand-alone)

Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	
1980 & newer non-electrically heated single detached homes	4419	100%	100%	4,419	
Pre-1980 non-electrically heated single detached homes	3741	100%	100%	3,741	
1980 & newer electrically heated single detached homes	672	100%	100%	672	
Pre-1980 electrically heated single detached homes	570	100%	100%	570	
Total SDH					
1980 & newer non-electrically heated attached/row housing	586	100%	100%	586	
Pre-1980 non-electrically heated attached/row housing	495	100%	100%	495	
1980 & newer electrically heated attached/row housing	89	100%	100%	89	
Pre-1980 electrically heated attached/row housing	76	100%	100%	76	
Total Attached					
Non-electrically heated apartment units	1268	100%	100%	1,268	
Non-electrically heated apartment common areas	72	100%	100%	72	
Electrically heated apartment units	198	100%	100%	198	
Electrically heated apartment common areas	11	100%	100%	11	
Total Apartment					
Non-electrically heated mobile/other	884	100%	100%	884	
Electrically heated mobile/other	129	100%	100%	129	
Total Mobile					
Small diesel grid housing	266	100%	100%	266	
Seasonal housing	862	100%	100%	862	
Residential garages	284	100%	100%	284	
Sentinel Lighting	947	100%	0%	0	
	15,569				
	Annual kWh	1,029		14,622	93.9%

One-Way Switch - Plug Loads

Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	
1980 & newer non-electrically heated single detached homes	4419	100%	100%	4,419	
Pre-1980 non-electrically heated single detached homes	3741	100%	100%	3,741	
1980 & newer electrically heated single detached homes	672	100%	100%	672	
Pre-1980 electrically heated single detached homes	570	100%	100%	570	
Total SDH					
1980 & newer non-electrically heated attached/row housing	586	100%	100%	586	
Pre-1980 non-electrically heated attached/row housing	495	100%	100%	495	
1980 & newer electrically heated attached/row housing	89	100%	100%	89	
Pre-1980 electrically heated attached/row housing	76	100%	100%	76	
Total Attached					
Non-electrically heated apartment units	1268	100%	100%	1,268	
Non-electrically heated apartment common areas	72	100%	100%	72	
Electrically heated apartment units	198	100%	100%	198	
Electrically heated apartment common areas	11	100%	100%	11	
Total Apartment					
Non-electrically heated mobile/other	884	100%	100%	884	
Electrically heated mobile/other	129	100%	100%	129	
Total Mobile					
Small diesel grid housing	266	100%	100%	266	
Seasonal housing	862	100%	100%	862	
Residential garages	284	100%	100%	284	
Sentinel Lighting	947	100%	0%	0	
	15,569				
	Annual kWh	545		14,622	93.9%

One-Way Switch - Pools/Spas

Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units		kWh/DU	div by El Sal
1980 & newer non-electrically heated single detached homes	4419	11%	89%	433		791	888.764
Pre-1980 non-electrically heated single detached homes	3741	11%	89%	366		721	810.1124
1980 & newer electrically heated single detached homes	672	10%	100%	67		814	814
Pre-1980 electrically heated single detached homes	570	9%	100%	51		742	742
Total SDH							843.6796
1980 & newer non-electrically heated attached/row housing	586	10%	89%	52			
Pre-1980 non-electrically heated attached/row housing	495	9%	89%	40			
1980 & newer electrically heated attached/row housing	89	9%	100%	8			
Pre-1980 electrically heated attached/row housing	76	8%	100%	6			
Total Attached							
Non-electrically heated apartment units	1268	0%	100%	0			
Non-electrically heated apartment common areas	72	8%	89%	5			
Electrically heated apartment units	198	0%	100%	0			
Electrically heated apartment common areas	11	8%	100%	1			
Total Apartment							
Non-electrically heated mobile/other	884	4%	91%	32			
Electrically heated mobile/other	129	4%	100%	5			
Total Mobile							
Small diesel grid housing	266	9%	91%	22			
Seasonal housing	862	4%	91%	31			
Residential garages	284	0%	100%	0			
Sentinel Lighting	947	0%	0%	0			
	15,569						
	Annual kWh	8,164		1,120	7.2%		

Appendix H Background-Section 10: Achievable Workshop Action Profile Slides

Appendix I Background-Section 10: Achievable Workshop Measure Worksheets

Yukon Electricity Conservation and Demand Management Potential Review (CPR 2011)

Residential Sector Appendices

9 January 2012

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Appendix H Background-Section 10: Achievable Workshop Action Profile Slides H-1

Appendix I Background-Section 10: Achievable Workshop Measure Worksheets I-1

Appendix A Background-Section 3: Base Year Electricity Use

Introduction

Appendix A provides additional detailed information related to each of the major steps employed to generate the profile of Residential sector Base Year electricity use. The major steps involved are:

- Step 1: Determine net space heating and cooling loads for each existing dwelling type
- Step 2: Determine annual electricity use for the existing stock of major residential appliances
- Step 3: Determine appliance saturation levels for each dwelling type
- Step 4: Determine electricity share for each appliance, by dwelling type
- Step 5: Calibrate to sales data for the study Base Year of 2010.

A.1 Step 1: Determine Net Space Heating Loads

Net space heating load is the space heating load of a building that must be met by the space heating system. This is equal to the total heat loss through the building envelope minus solar and internal gains. The net space heating loads for each dwelling type were developed based on the following combination of data sources:

- Marbek's database of residential energy consumption from other jurisdictions
- Current utility sales data combined with knowledge of the electricity consumption and saturation of other end uses.

The net space heating load for each dwelling type is given by the following equation:

$$NetHL_1 = HL_1 + a_{i,1} * s_{i,1}$$

Where: $NetHL_1$ = Net heating load for dwelling type #1
HL_1 = Load on primary heating appliance for dwelling type #1
$a_{i,1}$ = Average consumption for supplementary heating in dwelling type #1
$s_{i,1}$ = Saturation of supplementary heating in dwelling type #1

HL_1 was estimated for each dwelling type and service region, based on utility customer sales data for electrically and non-electrically heated dwellings combined with data on the electricity consumption of non-space heating end uses. The values for a_{i1} and s_{i1} were developed based on the estimated share of space heating that is provided by electricity (versus supplementary fuels), as taken from the Residential Electrical End Use Survey (REEUS). The net space heating loads are presented in Exhibit A 1.

It should be noted that the values shown in Exhibit A 1are not fuel specific; rather, they represent the total tertiary space heat load for each dwelling. The efficiency of the space heating appliances used to meet these loads is considered in subsequent stages of the analysis.

Exhibit A 1 Existing Residential Units, 2010, Net Space Heating Loads by Dwelling Type (kWh/yr.)

Dwelling Types	Tertiary Heating Load (kWh/yr.)			
	Hydro Grid	Large Diesel	Small Diesel	Old Crow
1980 & newer non-electrically heated single detached homes	20,538	19,866	-	-
Pre-1980 non-electrically heated single detached homes	28,753	27,813	-	-
1980 & newer electrically heated single detached homes	13,555	-	-	-
Pre-1980 electrically heated single detached homes	16,677	-	-	-
1980 & newer non-electrically heated attached/row housing	13,117	12,688	-	-
Pre-1980 non-electrically heated attached/row housing	17,971	17,383	-	-
1980 & newer electrically heated attached/row housing	7,411	-	-	-
Pre-1980 electrically heated attached/row housing	10,153	-	-	-
Non-electrically heated apartment units	10,380	8,535	-	-
Non-electrically heated apartment common areas	25,291	29,287	-	-
Electrically heated apartment units	6,021	-	-	-
Electrically heated apartment common areas	14,669	-	-	-
Non-electrically heated mobile/other	17,014	25,156	-	-
Electrically heated mobile/other	10,490	-	-	-
Small diesel grid housing	-	-	16,179	17,937
Seasonal housing	1,409	1,480	1,098	1,172
Residential garages	10,006	7,104	4,002	10,006

A.1.1 Development of Thermal Archetypes – Existing Stock

The next major step involved the development of a thermal archetype for each of the major dwelling types noted in Exhibit A 1 using HOT2000.

Each HOT2000 file contains a comprehensive physical description of the size, layout and thermal characteristics of each dwelling type. HOT2000 then uses these inputs to create a full computer model of the residence, calculating loads, interactive effects and energy consumption. In each case, the net heating and cooling loads simulated by HOT2000 were calibrated to the values shown in Exhibit A 1, which had been established on the basis of the sources described above. The process of calibrating simulation models to the loads estimated from available data served to further confirm the estimated loads. Adjustments were made to the estimates as required.

The physical and operating characteristics of each residential thermal archetype were researched using a number of sources, including:

- Database of EnerGuide for Houses (EGH) evaluations in Yukon provided by Yukon Housing Corporation
- Natural Resources Canada (NRCan) and Statistics Canada housing data
- Consultations with energy auditors and residential housing experts located in Yukon.

For the existing housing stock, archetypes were created for the two primary dwelling types in each service region: single-family detached and attached. A brief description of each housing archetype is provided below.

Single detached houses

A "typical" pre-1980 single-family detached dwelling can be defined as a single-story bungalow of approximately 170 m^2 (1,800 ft^2), including a finished basement. This home has 16.5 m^2 (177.5 ft^2) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.46 (R-14) insulation values, ceilings RSI-4.93 (R-28) and the basement is insulated to a value of RSI-2.29 (R-13) all the way to the basement floor. The houses are typically not very airtight, with an air change rate of about 6.0 ACH@50Pa (air changes per hour at 50 Pascal depressurization).

Typical newer dwellings (built since 1980) are approximately the same size as above. They tend to have more windows, approximately 19.0 m^2 (205 ft^2) of window area, but these are typically of higher performance, typically defined as low-e, argon-filled, double-glazed, mostly with vinyl frames. Walls are represented by RSI-2.99 (R-17) insulation values, ceilings RSI-5.98 (R-34) and the basement is insulated to a value of RSI-2.99 (R-17) all the way to the basement floor. The houses are more airtight, with an air change rate of about 5 ACH@50Pa.

Attached Dwellings

An average attached dwelling can be defined as a one-story end unit of approximately 125 m^2 (1,350 ft^2), including a finished basement. This home has 11.5 m^2 (125 ft^2) of windows, defined as double-glazed, mostly with wood or vinyl frames. Walls are represented by RSI-2.81 (R-16) insulation values, ceilings RSI-5.98 (R-34) and the basement is insulated to a value of RSI-2.46 (R-14) all the way to the basement floor. The houses are somewhat airtight, with an air change rate of about 5 ACH@50Pa.

A.2 Step 2: Determine Annual Appliance Electricity Use

The next major task involved the development of estimated average annual unit electricity consumption (UEC) values for each of the major residential appliances.

Electrical consumption of appliances is related to age. According to NRCan data[29] most appliances have increased in efficiency over time. Estimates of the evolving energy consumption of the stock of appliances in Yukon were developed using an appliance stock model that takes into account the expected useful life of each type of appliance, the rate of purchase and retirement of appliances, the average annual consumption of newly purchased appliances in a given year, and the average annual consumption of appliances being retired in a given year. The stock average consumption thus evolves with time. In any specific year, the average age of appliances in place is assumed to be half of the expected useful life of the appliance and the stock average is built up of all the appliances purchased and installed up to that point.

There is some evidence of a correlation between age of dwelling and age of the appliances in it, but it is not a strong relationship. Older homes likely have had major appliances replaced several times and newer homes can have old appliances transferred from previous residences. The difference in appliance electrical consumption as related to the age of the home was judged small enough to be neglected for the purposes of this study.

A more important driver of appliance electricity consumption is the difference in average number of occupants in different types of homes. This influences the size of some appliances, such as refrigerators, and the intensity of use for others, such as laundry and cooking appliances. The estimated annual electricity consumption of appliances by dwelling type reflects these differences.

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[29] NRCan, 2008. *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2006.*

Exhibit A 2 summarizes the estimated average annual UEC for the current stock mix of major end-use appliances, for accounts connected with the hydro grid.

The space heating end use has been omitted from Exhibit A 2 because it was presented in Exhibit A 1.

Exhibit A 2 Annual Appliance Unit Electricity Consumption (UEC), Hydro Grid Accounts (kWh/yr.)

Dwelling Types	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	602	3,453	1,029	288	28	716	638	461	116
Pre-1980 non-electrically heated single detached homes	610	3,453	1,029	288	28	716	638	461	116
1980 & newer electrically heated single detached homes	100	3,453	1,029	288	28	716	638	461	116
Pre-1980 electrically heated single detached homes	100	3,453	1,029	288	28	716	638	461	116
1980 & newer non-electrically heated attached/row housing	463	2,724	698	189	14	478	521	376	77
Pre-1980 non-electrically heated attached/row housing	469	2,724	698	189	14	478	521	376	77
1980 & newer electrically heated attached/row housing	100	2,724	698	189	14	478	521	376	77
Pre-1980 electrically heated attached/row housing	100	2,724	698	189	14	478	521	376	77
Non-electrically heated apartment units	359	1,483	499	54	6	411	526	380	66
Non-electrically heated apartment common areas	4,385	24,119	6,101	660	72	-	-	-	-
Electrically heated apartment units	50	1,483	499	54	6	411	526	380	66
Electrically heated apartment common areas	611	18,134	6,101	660	72	-	-	-	-
Non-electrically heated mobile/other	469	2,724	698	189	14	478	521	376	77
Electrically heated mobile/other	100	2,724	698	189	14	478	521	376	77
Small diesel grid housing	610	3,453	1,029	288	28	716	638	461	116
Seasonal housing	30	583	174	49	-	121	108	78	20
Residential garages	366	-	617	173	-	-	-	78	-
Sentinel Lighting	-	-	-	645	-	-	-	-	-

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other
1980 & newer non-electrically heated single detached homes	65	990	12,468	394	178	225	106	258	258	186
Pre-1980 non-electrically heated single detached homes	65	990	12,468	394	178	225	106	258	258	186
1980 & newer electrically heated single detached homes	65	990	12,468	394	178	225	106	258	258	186
Pre-1980 electrically heated single detached homes	65	990	12,468	394	178	225	106	258	258	186
1980 & newer non-electrically heated attached/row housing	43	660	12,468	394	178	225	72	258	258	126
Pre-1980 non-electrically heated attached/row housing	43	660	12,468	394	178	225	72	258	258	126
1980 & newer electrically heated attached/row housing	43	660	12,468	394	178	225	72	258	258	126
Pre-1980 electrically heated attached/row housing	43	660	12,468	394	178	225	72	258	258	126
Non-electrically heated apartment units	37	567	-	394	178	225	61	-	-	107
Non-electrically heated apartment common areas	457	6,938	24,936	-	-	-	-	3,151	3,151	-
Electrically heated apartment units	37	567	-	394	178	225	61	-	-	107
Electrically heated apartment common areas	457	6,938	24,936	-	-	-	-	3,151	3,151	-
Non-electrically heated mobile/other	43	660	12,468	394	178	225	72	258	258	126
Electrically heated mobile/other	43	660	12,468	394	178	225	72	258	258	126
Small diesel grid housing	65	990	12,468	394	178	225	106	258	258	186
Seasonal housing	11	167	6,234	67	30	38	18	-	-	31
Residential garages	-	-	-	-	-	-	-	258	258	1,200
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-

Occupancy

Occupancy rates[30] for each dwelling type were based on national Census data[31]. They are used, as applicable, to estimate electricity use for occupant-sensitive end uses, such as DHW, laundry and lighting. Exhibit A 3 summarizes the occupancy rates assumed for this study.

Exhibit A 3 Occupancy Rates by Dwelling Type

Household Sizes	Single Detached Houses	Double/Row Houses	Apartments	Mobile Homes
1 member	14%	23%	58%	36%
2 members	37%	36%	33%	64%
3 members	18%	18%	6%	0%
4 or more members	31%	23%	4%	0%
Approximate Average	2.7	2.4	1.6	1.6

Ventilation and Circulation

Ventilation electricity is associated with fan/blower electricity in heating systems, kitchen fans, bathroom fans and heat recovery ventilators.

A furnace fan UEC of approximately 510 kWh was assumed for single detached houses with forced air systems. This figure is consistent with estimates used in ICF Marbek's most recent studies in other jurisdictions and is somewhat lower than estimates used in earlier studies. This reflects the steady increase in the prevalence of ECM motors. The value is also consistent with the range of Canadian end-use metered data reported in a study conducted for Natural Resources Canada.[32]

For the purpose of estimating kitchen and bathroom fan electricity, it was assumed that a typical exhaust fan is rated at 75 Watts and operates, on average, for two hours per day. In homes with heat supplied by baseboard electric or by hydronic systems, these exhaust fans are the predominant ventilation load. With two such fans in a typical house, consumption would be approximately 100-110 kWh/yr.

The UEC for a forced air system includes the electricity consumed by both the furnace fan and the exhaust fans. The UEC for a baseboard electric system includes only the electricity consumed by the latter.

Note: The ventilation and circulation UEC values shown previously in Exhibit A 2 reflect the mix between forced air systems and baseboard systems.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, ventilation and circulation UEC was scaled according to tertiary heating load.

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[30] Electricity use related to personal consumption increases with number of occupants in dwelling.

[31] NRCan, 2007. *Survey of Household Energy Use 2007: Detailed Statistical Report.*

[32] This area is the focus of extensive research efforts. *See*: Gusdorf, John, *Final Report on the Project to Measure the Effects of ECM Furnace Motors on Gas Use at the CCHT Research Facility*, Natural Resources Canada, January 2003. Current estimates of fan energy use vary widely; upper range estimates (heat mode only) exceed 1,000 kWh/yr. Continuous ventilation or use with space cooling equipment would increase fan motor consumption.

Domestic Hot Water

UEC estimates for DHW assume a per capita hot water consumption of 45 litres per person per day and a temperature rise of 45°C. Exhibit A 4 shows the distribution of DHW load by major end use.

Exhibit A 4 Distribution of DHW Electricity Use by End Use in Existing Stock, (kWh/yr.)

DHW Sub End Uses	Electricity per Sub End Use (kWh/yr.)	Electricity per Sub End Use (%)
Clothes Washer	631	18%
Showers	897	26%
Faucets	641	19%
Baths	128	4%
Dishwasher	451	13%
Leaks	192	6%
Tank (Standby) Losses	256	7%
Pipe Losses	256	7%
Total	3,453	100%

Note: Any differences in totals are due to rounding.

The DHW values shown in Exhibit A 4 are based on a combination of sources including available data from other jurisdictions, NRCan studies (NRCan, 2005) and the results of other recent ICF Marbek studies.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, DHW and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Indoor Lighting

The indoor lighting loads shown in Exhibit A 2 were developed from the following sources:

- Residential utility data on lighting types and usage patterns from other jurisdictions
- Yukon's REEUS
- NRCan's End Use Energy Data Handbook (NRCan, 2005).

Exhibit A 5 shows the estimated counts of different types of lighting based on the data from the REEUS and residential lighting data from other ICF Marbek studies. Lighting counts have increased as larger houses have been built in Canada, but the hours of use for each lighting fixture has decreased at the same time.

The average wattage and hours of use per year shown in the exhibit are based on Marbek's energy use database, developed during several previous conservation potential studies. They were adjusted for consistency with the sources listed above. The resulting calculation shown in the exhibit provides a basis for the estimate of overall indoor lighting energy consumption for different dwelling types.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, lighting and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 5 Indoor Lighting by Dwelling Type

Dwelling Types	Incandescent Lamps	Linear Fluorescent Tubes	Compact Fluorescent Lamps	Halogen Lamps	
SDH	23	6	16	3	(lamps)
Attached	17	2	12	2	(lamps)
Apartment	13	1	8	1	(lamps)
Average Wattage	60	48	15	50	(watts)
Average Hours/Year	500	500	500	500	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	690	144	120	75	1029
Attached	510	48	90	50	698
Apartment	390	24	60	25	499

Outdoor Lighting

The outdoor lighting loads shown in Exhibit A 2 were developed from the following sources:

- Residential utility data on lighting types and usage patterns from other jurisdictions
- Yukon's REEUS
- NRCan's End Use Energy Data Handbook (NRCan, 2005).

Exhibit A 6 shows the estimated counts of different types of lighting based on the data from the REEUS and residential lighting data from other ICF Marbek studies.

The average wattage and hours of use per year shown in the exhibit are based on Marbek's energy use database, developed during several previous conservation potential studies. They were adjusted for consistency with the sources listed above. The resulting calculation shown in the exhibit provides a basis for the estimate of overall outdoor lighting energy consumption for different dwelling types.

For the accounts connected to the large and small diesel and Old Crow systems, lighting and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 6 Outdoor Lighting by Dwelling Type

Dwelling Types	Incandescent Lamps	Linear Fluorescent Tubes	Compact Fluorescent Lamps	
SDH	4	1	2	(lamps)
Attached	3	0	1	(lamps)
Apartment	1	0	0	(lamps)
Average Wattage	60	48	15	(watts)
Average Hours/Year	900	365	1800	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)				Total
SDH	216	18	54	288
Attached	162	0	27	189
Apartment	54	0	0	54

Holiday Lighting

The holiday lighting loads shown in Exhibit A 2 were developed from the following sources:

- Residential utility data on lighting types and usage patterns from other jurisdictions
- Yukon's REEUS
- NRCan's End Use Energy Data Handbook (NRCan, 2005).

Exhibit A 7 shows the estimated counts of different types of holiday lighting based on the data from the REEUS and residential lighting data from other ICF Marbek studies.

The average wattage and hours of use per year shown in the exhibit are based on Marbek's energy use database, developed during several previous conservation potential studies. They were adjusted for consistency with the sources listed above. The resulting calculation shown in the exhibit provides a basis for the estimate of overall holiday lighting energy consumption for different dwelling types.

For the accounts connected to the large and small diesel and Old Crow systems, lighting and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 7 Holiday Lighting by Dwelling Type

Dwelling Types	Indoor Incandescent Holiday Strings	Indoor LED Holiday Strings	Outdoor Incandescent Holiday Strings	Outdoor LED Holiday Strings	
SDH	2	9	2	6	(lamps)
Attached	1	5	1	4	(lamps)
Apartment	1	2	0	0	(lamps)
Average Wattage	60	1	60	1	(watts)
Average Hours/Year	95	95	125	125	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	11	1	15	1	28
Attached	6	0	8	1	14
Apartment	6	0	0	0	6

Cooking Appliances, Refrigerator, Freezer and Dishwasher

UEC estimates for the existing stock of this group of food preparation and storage appliances were obtained from *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2006* (NRCan, 2008). The values shown for dishwashers are for mechanical electricity only; hot water use is included with the DHW UEC.

For the accounts connected to the large and small diesel and Old Crow systems, appliances and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Clothes Washer and Dryer

Appliance UEC data was obtained from *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2006* (NRCan, 2008). The values shown for clothes washers are for mechanical electricity only; hot water use is included with the DHW UEC.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, appliances and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Computers

UEC data for computers is based on calculations drawing on data from the *Survey of Household Energy Use 2007: Detailed Statistical Report* (NRCan, 2007) and is consistent with Marbek's previous work for BC Hydro.[33]

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, electronics and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

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[33] Marbek Resource Consultants, *Conservation Potential Review – 2007*. Prepared for BC Hydro. 2007.

Television

UEC data for televisions was obtained from *Technology and Market Profile: Consumer Electronics* (Marbek, 2006). Saturation of televisions (number of sets per household) is adjusted by dwelling type based on data from the REEUS but consumption per television is not varied by dwelling type in this study.

For the accounts connected to the large and small diesel and Old Crow systems, electronics and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Television Peripherals

UECs, saturations and numbers per household for television peripherals were obtained from *Technology and Market Profile: Consumer Electronics* (Marbek, 2006) and other published data. In some parts of Canada, internet protocol television (IP-TV) is becoming a major player in the marketplace. The equipment for IP-TV uses about 40% less than the average cable or satellite system. IP-TV is assumed to occupy only a very small part of the Yukon market at this time, and has not been included in the calculations for this study. The weighted UEC for this end use as a whole was generated from the numbers shown in Exhibit A 8. UEC is not varied by dwelling type in this study.

For the accounts connected to the Large Diesel, Small Diesel, and Old Crow systems, electronics and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 8 Derivation of UEC for Television Peripherals

	% of TV households	UEC kWh/yr.
Digital Cable Service	38%	
Digital Adaptor	38%	82
Standard Digital STB	31%	194
Advanced Digital STB	7%	325
Average UEC		299
Satellite Service	47%	
Standard Satellite STB	38%	141
Advanced Satellite STB	9%	273
Average UEC		166
Total Weighted UEC		226

Home Entertainment Electronics

Due to the large presence of electronic entertainment devices in many residential dwellings, this end use was separated from the general “other” category. UECs were obtained from *Technology and Market Profile: Consumer Electronics* (Marbek, 2006), *Residential Miscellaneous Electricity Use* (LBL) and other published data. A weighted UEC for the end use as a whole was generated based on recent ICF Marbek studies, as shown in Exhibit A 9.

For the accounts connected to the large and small diesel and Old Crow systems, electronics and all the other non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 9 Derivation of UECs for Other Electronics

	Penetration	Number Per Household	UEC (kWh/yr.)	Weighted UEC (kWh/yr.)
DVD	72%	1.2	35	30
VCR	69%	1.3	55	49
Audio System	29%	1.3	55	21
Surround Sound	25%	1.0	50	13
Compact Audio	79%	1.5	25	30
Game Console	25%	1.3	55	18
	Total Weighted UEC			160

Spas

This end use includes only spas. The incidence of swimming pools in Yukon is assumed to be small. The UEC includes the spa heater if it is electric, and also includes the consumption of the pump. Figures are derived from ICF Marbek's previous work in other jurisdictions and manufacturer literature on spa heater consumption. Exhibit A 10 shows the derivation of the UECs used in Exhibit A 2. The market penetration numbers in the exhibit are estimates of the shares of each technology within the subset of spas with that electric end use. For example, the estimate of 75% spa heaters using resistance heating elements is the share of electrically heated spas using resistance heat. Spas that are heated with propane or solar are not included. For the accounts connected to the large and small diesel and Old Crow systems, all non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

Exhibit A 10 Derivation of UECs for Spas

	UEC (kWh/yr.)	Market Penetration	Weighted UEC (kWh/yr.)
Spa Heaters			
Resistance	13,341	75%	10,006
Heat Pump	4,447	25%	1,112
	Weighted UEC		11,118
Spa Pumps			
Standard	1,500	75%	1,125
High Efficiency	900	25%	225
	Weighted UEC		1,350
	Total Weighted UEC		12,468

Block Heaters and Car Warmers

Consumption for block heaters was based on previous studies in other jurisdictions. Block heaters typically draw 500 watts. They were assumed to be used an average of 6.7 hours/day for 90 days of the year. Approximately one-quarter of them were assumed to be on timers, which would reduce their runtime by 70%. The resulting total consumption of block heaters was estimated at 228 kWh/yr. The car warmers use more power, typically 1200 watts. They were assumed to be used for only about four hours per day, but over a longer season of 110 days.

More of them were assumed to be on timers – nearly half – with savings of about 50% of runtime. The resulting total consumption of car warmers was estimated at 400 kWh/yr. There are fewer car warmers than block heaters in use – approximately one car warmer for every 14 block heaters according to the Yukon REEUS. Therefore, the car warmers were assumed to add only about 30 kWh/yr. to the total consumption for this end use, bringing it to 258 kWh/yr.

Heat Tape, Propane Heaters, and Circulation Pumps

This end use includes electric plug-in devices for preventing water lines from freezing, including both heat tape and circulation pumps, and devices for warming outdoor propane tanks so the propane will flow easily. Because the devices included are so varied, it is difficult to estimate an overall annual consumption for the end use as a whole. The consumption for block heaters and car warmers, 258 kWh/yr., was used as an estimate.

Small Appliances and Other

"Other" end uses include a wide range of appliances and equipment found in most homes. Reliable data on the actual annual electricity use of this collection of appliances and equipment within Yukon is not available.

Exhibit A 11 illustrates the major items included in this end use and presents sample UEC data estimated in earlier studies undertaken in other jurisdictions.[34] It should be noted that actual UECs for individual appliances will vary from those shown in Exhibit A 11 and are affected by factors such as saturations by dwelling type and occupancy rates. Saturation information from LBL was not applied for this study because reliable information for Yukon was not available. The "other" category is not built up based on detailed analysis, but is an approximation only. The LBL data provided should be treated as being illustrative of the types of energy-using items in the category and how much electricity they typically use.

For the accounts connected to the large and small diesel and Old Crow systems, all non-HVAC UECs were scaled to best fit actual electricity sales to the accounts on those systems.

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[34] Lawrence Berkeley National Laboratory (LBL), *Residential Miscellaneous Electricity Use*, 1997.

Exhibit A 11 Typical UECs for Selected "Other" Appliances

Appliance	UEC (kWh/yr.)	Appliance	UEC (kWh/yr.)
Home radio, small/clock	18	Timer	18
Battery Charger	21	Hot Plate	30
Clock	18	Stand Mixers	1
Power Strip	3	Hand-Held Rechargeable	16
Vacuum	31	Hand-Held Electric Vacuum	4
Hand Mixers	2	Air Corn Popper	6
Iron	53	Security System	195
Hair Dryer	36	Perc Coffee	65
Toaster	39	Deep Fryer	20
Auto Coffee Maker	116	Waterbed Heaters	900
Blender	7	Humidifier	100
Heating Pads	3	Electric Toothbrush	20
Doorbell	18	Hot Oil Corn Popper	2
Answering Machine	29	Women's Shaver	12
Can Opener	3	Aquariums	548
Slow Cooker	16	Espresso Maker	19
Curling Iron	1	Electric Lawn Mower	100
Food Slicer	1	Mounted Air Cleaner	500
Garbage Disposer	10	Multi-fcn Device	41
Electric Knife	1	Electric Kettle	75
Portable Fans	8	Bottled Water Dispenser	300
Men's Shaver	13	Central Vacuum	24
Waffle Iron/Sandwich Grill	25	Grow Lights	800
Electric Blankets	120	Home Medical Equipment	400
Garage Door Opener	30		
Hair Setter	10		

A.3 Step 3: Determine Appliance Saturation, by Dwelling Type

Exhibit A 12 summarizes the saturation levels that are used in the present analysis. The assumed saturation levels are developed from the most recent REEUS. End uses fall into several categories:

- Some end uses are present in 100% of fully-occupied dwellings, including space heating,[35] ventilation and circulation, DHW, indoor and outdoor lighting, cooking, home entertainment electronics, and small appliance and other. These end uses are analyzed on the basis of UEC per dwelling, rather than UEC per appliance. Some of these end uses are not assumed to be present in all of the seasonal accounts, as the exhibit shows. Sentinel lighting, of course, includes only the outdoor lighting end use.
- Most of the remaining end uses are analyzed on the basis of UEC per appliance. Their saturation, as indicated in the table, reflects the average number of appliances per household. For example, the average household includes more than one refrigerator, and the saturation values in the exhibit reflect that.

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[35] Note that saturation of space heating, DHW, and cooking do not reflect how many households use electricity for those purposes. Electric share is discussed in the next section.

Exhibit A 12 Appliance Saturation Levels, (%)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	100%	100%	100%	100%	100%	100%	100%	135%	118%	86%
Pre-1980 non-electrically heated single detached homes	100%	100%	100%	100%	100%	100%	100%	123%	107%	79%
1980 & newer electrically heated single detached homes	100%	100%	100%	100%	100%	100%	100%	123%	107%	79%
Pre-1980 electrically heated single detached homes	100%	100%	100%	100%	100%	100%	100%	112%	98%	72%
1980 & newer non-electrically heated attached/row housing	100%	100%	100%	100%	100%	100%	100%	129%	112%	82%
Pre-1980 non-electrically heated attached/row housing	100%	100%	100%	100%	100%	100%	100%	114%	99%	73%
1980 & newer electrically heated attached/row housing	100%	100%	100%	100%	100%	100%	100%	117%	102%	75%
Pre-1980 electrically heated attached/row housing	100%	100%	100%	100%	100%	100%	100%	104%	90%	66%
Non-electrically heated apartment units	100%	100%	80%	100%	100%	100%	100%	100%	87%	64%
Non-electrically heated apartment common areas	100%	100%	20%	100%	100%	100%	0%	0%	0%	0%
Electrically heated apartment units	100%	100%	100%	100%	100%	100%	100%	100%	87%	64%
Electrically heated apartment common areas	100%	100%	0%	100%	100%	100%	0%	0%	0%	0%
Non-electrically heated mobile/other	100%	100%	100%	100%	100%	100%	100%	100%	87%	64%
Electrically heated mobile/other	100%	100%	100%	100%	100%	100%	100%	100%	87%	64%
Small diesel grid housing	100%	100%	100%	100%	100%	100%	100%	112%	98%	72%
Seasonal housing	50%	50%	50%	100%	100%	20%	50%	50%	44%	32%
Residential garages	100%	100%	0%	100%	100%	100%	0%	0%	0%	0%
Sentinel Lighting	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other
1980 & newer non-electrically heated single detached homes	124%	114%	13%	260%	232%	116%	100%	109%	28%	100%
Pre-1980 non-electrically heated single detached homes	113%	104%	12%	237%	211%	105%	100%	100%	25%	100%
1980 & newer electrically heated single detached homes	113%	103%	12%	237%	211%	105%	100%	100%	25%	100%
Pre-1980 electrically heated single detached homes	103%	94%	11%	216%	192%	96%	100%	91%	23%	100%
1980 & newer non-electrically heated attached/row housing	118%	108%	13%	248%	221%	110%	100%	104%	26%	100%
Pre-1980 non-electrically heated attached/row housing	104%	96%	11%	219%	195%	97%	100%	92%	23%	100%
1980 & newer electrically heated attached/row housing	107%	98%	11%	225%	201%	100%	100%	95%	24%	100%
Pre-1980 electrically heated attached/row housing	95%	87%	10%	200%	178%	89%	100%	84%	21%	100%
Non-electrically heated apartment units	46%	42%	0%	193%	172%	86%	100%	0%	0%	100%
Non-electrically heated apartment common areas	46%	42%	10%	0%	0%	0%	100%	81%	20%	100%
Electrically heated apartment units	46%	42%	0%	193%	172%	86%	100%	0%	0%	100%
Electrically heated apartment common areas	46%	42%	10%	0%	0%	0%	100%	81%	20%	100%
Non-electrically heated mobile/other	92%	84%	5%	193%	172%	86%	100%	81%	20%	100%
Electrically heated mobile/other	92%	84%	5%	193%	172%	86%	100%	81%	20%	100%
Small diesel grid housing	103%	94%	11%	216%	192%	96%	100%	91%	23%	100%
Seasonal housing	46%	42%	5%	96%	86%	43%	100%	0%	0%	100%
Residential garages	0%	0%	0%	0%	0%	0%	100%	91%	23%	100%
Sentinel Lighting	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

A.4 Step 4: Determine Fuel Share, by End Use and Dwelling Type

Data on fuel shares, for all end uses except space heating and DHW, is taken from the most recent Yukon REEUS. In the case of space heating, the starting point was the distribution of space heating appliances, by fuel type, as reported in the surveys and in the REEUS and the EnerGuide for Houses database, but the actual fuel share includes not only the presence of different appliances but also how much they are used. In particular it is affected by supplementary heating appliances, such as:

- Electric space heaters in non-electrically heated dwellings
- Non-electric sources (e.g., wood stoves) in electrically heated dwellings.

The space heating fuel shares presented in the exhibit[36] have been selected on the basis that they provide a reasonable fit with:

- General market description (i.e., known distribution of heating appliances by fuel)
- Electricity sales to different categories of homes.

Exhibit A 13 summarizes the electricity fuel shares assumed for each of the end uses included in the present analysis.

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[36] Adjustment of fuel shares for space heating was done in tandem with the adjustment of space heating loads described in Section 3.4 above.

Exhibit A 13 Electricity Fuel Shares, (%)

Dwelling Types	Space heating	Domestic hot water (DHW)	Cooking appliances	Clothes dryer	Spa heaters and pumps
1980 & newer non-electrically heated single detached homes	5%	79%	91%	97%	89%
Pre-1980 non-electrically heated single detached homes	5%	79%	91%	97%	89%
1980 & newer electrically heated single detached homes	89%	100%	100%	100%	100%
Pre-1980 electrically heated single detached homes	89%	100%	100%	100%	100%
1980 & newer non-electrically heated attached/row housing	5%	79%	91%	97%	89%
Pre-1980 non-electrically heated attached/row housing	5%	79%	91%	97%	89%
1980 & newer electrically heated attached/row housing	89%	100%	100%	100%	100%
Pre-1980 electrically heated attached/row housing	89%	100%	100%	100%	100%
Non-electrically heated apartment units	5%	100%	91%	97%	100%
Non-electrically heated apartment common areas	5%	0%	100%	97%	89%
Electrically heated apartment units	95%	100%	100%	100%	100%
Electrically heated apartment common areas	95%	100%	100%	100%	100%
Non-electrically heated mobile/other	5%	79%	92%	97%	91%
Electrically heated mobile/other	89%	100%	100%	100%	100%
Small diesel grid housing	4%	83%	92%	97%	91%
Seasonal housing	5%	83%	92%	97%	91%
Residential garages	5%	100%	100%	100%	100%

A.5 Step 5: Calibrate to sales data for the study Base Year of 2010

YEC and YECL provided electricity sales data for the year 2010, which was the latest year for which a complete year of data was available at the time of the study. Electricity sales were divided among the dwelling types and vintages according to the best information available from the utilities customer databases and from Marbek's energy end-use modelling. The RSEEM model was populated with data for UEC, saturation and electricity share and calibrated for a close match to the 2010 sales data.

A.6 Results by Supply System

This section of the appendix presents the base year electricity consumption for the hydro grid, large diesel, small diesel, and Old Crow supply systems. For each supply system, versions of Exhibit 6 and Exhibit 7 (which appear in Section 3 of the main body of the report) are provided below. The underlying assumptions such as unit energy consumption, saturation and electricity share are not presented by supply system. In general, the sample sizes for the diesel supply systems are too small to develop these detailed assumptions for the houses there. Instead, the end use consumptions are scaled to calibrate the model to the sales of electricity in those regions.

This section also does not replicate the pie charts and other graphs presented in Section 3. If those graphs are needed for each supply system, they can be created using the Data Manager.

Exhibit A 14 Average Electricity Use per Dwelling Unit, Hydro Grid Accounts (kWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	1,027	602	2,742	1,029	288	28	651	862	543	100
Pre-1980 non-electrically heated single detached homes	1,438	610	2,742	1,029	288	28	651	785	495	91
1980 & newer electrically heated single detached homes	12,075	100	3,453	1,029	288	28	716	784	494	91
Pre-1980 electrically heated single detached homes	14,856	100	3,453	1,029	288	28	716	715	450	83
1980 & newer non-electrically heated attached/row housing	656	463	2,164	698	189	14	434	669	422	63
Pre-1980 non-electrically heated attached/row housing	899	469	2,164	698	189	14	434	592	373	56
1980 & newer electrically heated attached/row housing	6,602	100	2,724	698	189	14	478	609	384	58
Pre-1980 electrically heated attached/row housing	9,045	100	2,724	698	189	14	478	539	340	51
Non-electrically heated apartment units	519	359	1,186	499	54	6	374	526	332	42
Non-electrically heated apartment common areas	1,265	4,385	-	6,101	660	72	-	-	-	-
Electrically heated apartment units	5,719	50	1,483	499	54	6	411	526	332	42
Electrically heated apartment common areas	13,935	611	-	6,101	660	72	-	-	-	-
Non-electrically heated mobile/other	851	469	2,164	698	189	14	441	521	328	49
Electrically heated mobile/other	9,345	100	2,724	698	189	14	478	521	328	49
Seasonal housing	35	15	241	174	49	-	56	54	34	6
Residential garages	500	366	-	617	173	-	-	-	-	-
Sentinel Lighting	-	-	-	-	645	-	-	-	-	-
Weighted Average	1,791	394	1,805	746	222	16	420	525	331	57

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total
1980 & newer non-electrically heated single detached homes	81	1,091	1,466	1,025	412	260	106	282	71	186	12,851
Pre-1980 non-electrically heated single detached homes	74	995	1,336	934	376	237	106	257	65	186	12,721
1980 & newer electrically heated single detached homes	73	1,024	1,505	933	375	237	106	257	65	186	23,819
Pre-1980 electrically heated single detached homes	67	934	1,372	850	342	216	106	234	59	186	26,083
1980 & newer non-electrically heated attached/row housing	51	692	1,395	975	392	248	72	269	68	126	10,060
Pre-1980 non-electrically heated attached/row housing	45	613	1,235	863	347	219	72	238	60	126	9,706
1980 & newer electrically heated attached/row housing	47	650	1,432	888	357	226	72	244	62	126	15,959
Pre-1980 electrically heated attached/row housing	41	575	1,267	786	316	200	72	216	54	126	17,832
Non-electrically heated apartment units	17	232	-	758	305	193	61	-	-	107	5,571
Non-electrically heated apartment common areas	209	2,833	2,179	-	-	-	-	2,553	643	-	20,900
Electrically heated apartment units	17	239	-	758	305	193	61	-	-	107	10,803
Electrically heated apartment common areas	209	2,917	2,447	-	-	-	-	2,553	643	-	30,149
Non-electrically heated mobile/other	40	541	554	758	305	193	72	209	53	126	8,574
Electrically heated mobile/other	40	555	612	758	305	193	72	209	53	126	17,368
Seasonal housing	5	69	277	64	26	16	18	-	-	31	1,170
Residential garages	-	-	-	-	-	-	-	234	59	1,200	3,149
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	645
Weighted Average	47	638	870	658	265	167	69	189	48	144	9,401

Exhibit A 15 Average Electricity Use per Dwelling Unit, Large Diesel Accounts (kWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	1,391	582	2,742	1,029	288	28	651	862	543	100
Pre-1980 non-electrically heated single detached homes	1,947	590	2,742	1,029	288	28	651	785	495	91
1980 & newer non-electrically heated attached/row housing	888	448	2,164	698	189	14	434	669	422	63
Pre-1980 non-electrically heated attached/row housing	1,217	454	2,164	698	189	14	434	592	373	56
Non-electrically heated apartment units	427	295	1,008	424	46	5	318	448	282	36
Non-electrically heated apartment common areas	1,464	3,605	-	4,332	469	51	-	-	-	-
Non-electrically heated mobile/other	1,258	693	2,315	747	202	15	472	557	351	53
Seasonal housing	37	14	253	183	51	-	59	57	36	7
Residential garages	355	354	-	438	122	-	-	-	-	-
Sentinel Lighting	-	-	-	-	645	-	-	-	-	-
Weighted Average	943	388	1,657	650	242	15	385	488	307	54

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total
1980 & newer non-electrically heated single detached homes	81	1,091	1,466	1,025	412	260	108	282	71	186	13,195
Pre-1980 non-electrically heated single detached homes	74	995	1,336	934	378	237	108	257	65	186	13,210
1980 & newer non-electrically heated attached/row housing	51	692	1,395	975	392	248	72	269	68	126	10,277
Pre-1980 non-electrically heated attached/row housing	45	613	1,235	863	347	219	72	238	60	126	10,009
Non-electrically heated apartment units	15	197	-	645	259	164	52	-	-	91	4,711
Non-electrically heated apartment common areas	149	2,011	1,547	-	-	-	-	1,813	456	-	15,897
Non-electrically heated mobile/other	43	579	593	812	326	206	77	223	56	135	9,713
Seasonal housing	5	72	291	67	27	17	19	-	-	33	1,227
Residential garages	-	-	-	-	-	-	-	166	42	852	2,330
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	645
Weighted Average	43	584	818	611	246	155	65	164	41	131	7,987

Exhibit A 16 Average Electricity Use per Dwelling Unit, Small Diesel Accounts (kWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
Small diesel grid housing	647	424	2,627	947	265	26	609	658	414	76
Seasonal housing	11	11	235	170	47	-	55	53	33	6
Residential garages	160	199	-	227	63	-	-	-	-	-
Sentinel Lighting	-	-	-	-	619	-	-	-	-	-
Grand Total	308	205	1,285	488	304	12	298	320	202	37

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total
Small diesel grid housing	62	837	1,143	782	315	199	97	215	54	171	10,567
Seasonal housing	5	67	270	63	25	16	17	-	-	31	1,114
Residential garages	-	-	-	-	-	-	-	86	22	442	1,200
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	619
Grand Total	30	408	600	381	153	97	50	102	26	96	5,401

Exhibit A 17 Average Electricity Use per Dwelling Unit, Old Crow Accounts (kWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
Small diesel grid housing	717	470	2,912	1,050	293	29	675	729	459	85
Seasonal housing	12	11	251	181	51	-	58	56	35	6
Sentinel Lighting	-	-	-	-	477	-	-	-	-	-
Grand Total	388	256	1,666	641	186	15	386	414	261	48

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total
Small diesel grid housing	68	928	1,267	867	349	220	108	239	60	190	11,715
Seasonal housing	5	71	288	67	27	17	19	-	-	33	1,188
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	477
Grand Total	39	527	806	492	198	125	66	127	32	116	6,788

Exhibit A 18 Electricity Consumption by End Use and Dwelling Type in the Base Year (2010), Hydro Grid Accounts (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	3,302	1,934	8,817	3,309	925	90	2,093	2,771	1,745	321
Pre-1980 non-electrically heated single detached homes	3,915	1,660	7,467	2,802	783	76	1,772	2,139	1,347	248
1980 & newer electrically heated single detached homes	6,267	52	1,792	534	149	15	372	407	256	47
Pre-1980 electrically heated single detached homes	6,522	44	1,516	452	126	12	315	314	198	36
1980 & newer non-electrically heated attached/row housing	279	197	921	297	80	6	185	285	180	27
Pre-1980 non-electrically heated attached/row housing	323	169	779	251	68	5	156	213	134	20
1980 & newer electrically heated attached/row housing	456	7	188	48	13	1	33	42	26	4
Pre-1980 electrically heated attached/row housing	534	6	161	41	11	1	28	32	20	3
Non-electrically heated apartment units	691	478	1,580	665	72	8	499	701	442	56
Non-electrically heated apartment common areas	186	644	-	896	97	11	-	-	-	-
Electrically heated apartment units	1,230	11	319	107	12	1	88	113	71	9
Electrically heated apartment common areas	334	15	-	146	16	2	-	-	-	-
Non-electrically heated mobile/other	684	377	1,740	561	152	11	355	419	264	40
Electrically heated mobile/other	1,205	13	351	90	24	2	62	67	42	6
Seasonal housing	109	46	744	536	150	-	172	166	105	19
Residential garages	132	96	-	163	45	-	-	-	-	-
Sentinel Lighting	-	-	-	-	515	-	-	-	-	-
Grand Total	26,170	5,749	26,375	10,900	3,239	241	6,129	7,669	4,829	838

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
1980 & newer non-electrically heated single detached homes	260	3,510	4,715	3,296	1,326	837	339	907	228	599	41,323	30%
Pre-1980 non-electrically heated single detached homes	200	2,709	3,640	2,544	1,023	646	287	700	176	507	34,644	25%
1980 & newer electrically heated single detached homes	38	532	781	484	195	123	55	133	34	97	12,362	9%
Pre-1980 electrically heated single detached homes	29	410	602	373	150	95	46	103	26	82	11,450	8%
1980 & newer non-electrically heated attached/row housing	22	295	594	415	167	106	30	114	29	54	4,284	3%
Pre-1980 non-electrically heated attached/row housing	16	221	445	311	125	79	26	86	22	45	3,494	3%
1980 & newer electrically heated attached/row housing	3	45	99	61	25	16	5	17	4	9	1,101	1%
Pre-1980 electrically heated attached/row housing	2	34	75	46	19	12	4	13	3	7	1,052	1%
Non-electrically heated apartment units	23	309	-	1,010	406	257	81	-	-	143	7,421	5%
Non-electrically heated apartment common areas	31	416	320	-	-	-	-	375	94	-	3,069	2%
Electrically heated apartment units	4	51	-	163	66	41	13	-	-	23	2,323	2%
Electrically heated apartment common areas	5	70	59	-	-	-	-	61	15	-	724	0.5%
Non-electrically heated mobile/other	32	435	446	610	245	155	58	168	42	102	6,896	5%
Electrically heated mobile/other	5	72	79	98	39	25	9	27	7	16	2,241	2%
Seasonal housing	16	212	855	198	80	50	55	-	-	97	3,610	3%
Residential garages	-	-	-	-	-	-	-	62	16	316	830	1%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	515	0.4%
Grand Total	686	9,319	12,708	9,610	3,866	2,441	1,009	2,766	696	2,097	137,337	100%

Exhibit A 19 Electricity Consumption by End Use and Dwelling Type in the Base Year (2010), Large Diesel Accounts (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
1980 & newer non-electrically heated single detached homes	264	110	520	195	55	5	123	163	103	19
Pre-1980 non-electrically heated single detached homes	313	95	440	165	46	4	105	126	79	15
1980 & newer non-electrically heated attached/row housing	22	11	54	18	5	0	11	17	11	2
Pre-1980 non-electrically heated attached/row housing	26	10	46	15	4	0	9	13	8	1
Non-electrically heated apartment units	19	13	44	18	2	0	14	20	12	2
Non-electrically heated apartment common areas	4	10	-	12	1	0	-	-	-	-
Non-electrically heated mobile/other	100	55	184	59	16	1	37	44	28	4
Seasonal housing	7	3	46	33	9	-	11	10	6	1
Residential garages	6	6	-	7	2	-	-	-	-	-
Sentinel Lighting	-	-	-	-	55	-	-	-	-	-
Grand Total	760	313	1,335	523	195	12	310	393	248	43

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
1980 & newer non-electrically heated single detached homes	15	207	278	194	78	49	20	54	13	35	2,503	39%
Pre-1980 non-electrically heated single detached homes	12	160	215	150	60	38	17	41	10	30	2,122	33%
1980 & newer non-electrically heated attached/row housing	1	17	35	25	10	6	2	7	2	3	258	4%
Pre-1980 non-electrically heated attached/row housing	1	13	26	18	7	5	2	5	1	3	213	3%
Non-electrically heated apartment units	1	9	-	28	11	7	2	-	-	4	205	3%
Non-electrically heated apartment common areas	0	6	4	-	-	-	-	5	1	-	45	1%
Non-electrically heated mobile/other	3	46	47	64	26	16	6	18	4	11	771	12%
Seasonal housing	1	13	53	12	5	3	3	-	-	6	223	3%
Residential garages	-	-	-	-	-	-	-	3	1	14	38	1%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	55	1%
Grand Total	35	471	659	492	198	125	52	132	33	106	6,434	100%

Exhibit A 20 Electricity Consumption by End Use and Dwelling Type in the Base Year (2010), Small Diesel Accounts (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
Small diesel grid housing	69	45	282	102	28	3	65	71	44	8
Seasonal housing	1	1	13	9	3	-	3	3	2	0
Residential garages	1	1	-	1	0	-	-	-	-	-
Sentinel Lighting	-	-	-	-	38	-	-	-	-	-
Grand Total	71	47	295	112	70	3	68	73	46	9

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
Small diesel grid housing	7	90	123	84	34	21	10	23	6	18	1,133	91%
Seasonal housing	0	4	15	4	1	1	1	-	-	2	62	5%
Residential garages	-	-	-	-	-	-	-	0	0	2	5	0%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	38	3%
Grand Total	7	94	138	87	35	22	11	23	6	22	1,239	100%

Exhibit A 21 Electricity Consumption by End Use and Dwelling Type in the Base Year (2010), Old Crow Accounts (MWh/yr.)

Dwelling Types	Space heating	Ventilation & circulation	Domestic hot water (DHW)	Indoor lighting	Outdoor lighting	Holiday lighting	Cooking appliances	Refrigerator	Freezer	Dishwasher
Small diesel grid housing	55	36	223	80	22	2	52	56	35	6
Seasonal housing	1	1	16	12	3	-	4	4	2	0
Sentinel Lighting	-	-	-	-	1	-	-	-	-	-
Grand Total	56	37	239	92	27	2	55	59	37	7

Dwelling Types	Clothes washer	Clothes dryer	Spa heaters and pumps	Computer and peripherals	Television	Set-top boxes	Home entertainment electronics	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Small appliance & other	Total	Percentage of Total
Small diesel grid housing	5	71	97	66	27	17	8	18	5	15	895	92%
Seasonal housing	0	5	19	4	2	1	1	-	-	2	77	8%
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	1	0%
Grand Total	6	76	116	71	28	18	9	18	5	17	973	100%

Appendix B Background-Section 4: Base Year Peak Load

Introduction

Appendix B provides additional detailed information related to each of the major steps employed in the generation of the Residential sector Base Year peak loads. The discussion is organized as follows:

- Overview of peak load methodology
- Segmentation of residential dwellings
- Detailed results.

B.1 Overview of Peak Load Profile Methodology

As noted in the main text, development of the electric peak load estimates employs four specific factors as outlined below:

- **Monthly Usage Allocation Factor:** This factor represents the percent of annual electric energy usage that is allocated to each month. This set of monthly fractions (percentages) reflects the seasonality of the load shape, whether a facility, process or end use, and is dictated by weather or other seasonal factors. This allocation factor can be obtained from either (in decreasing order of priority): (a) monthly consumption statistics from end-use load studies; (b) monthly seasonal sales (preferably weather normalized) obtained by subtracting a “base” month from winter and summer heating and cooling months; or (c) heating or cooling degree days on an appropriate base.
- **Weekend to Weekday Factor:** This factor is a ratio that describes the relationship between weekends and weekdays, reflecting the degree of weekend activity inherent in the facility or end use. This may vary by month or season. Based on this ratio, the average electric energy per day type can be computed from the corresponding monthly electric energy.
- **Peak Day Factor:** This factor reflects the degree of daily weather sensitivity associated with the load shape, particularly heating or cooling; it compares a peak (e.g., hottest or coldest) day to a typical weekday in that month.
- **Per Unit Hourly Factor:** The relationship of load among different hours of the day for each day type (weekday, weekend day, peak day) and for each month reflects the operating hours of the electric equipment or end use within residences by sub sector. For example, for lighting, this would be affected by time of day, season (affected by daylight), and room type, where applicable. For the Base Year, lighting is treated on an aggregate basis by total residence.

The four factors (sets of ratios) defined above provide the basis for converting annual energy to any hourly demand specified including the grouping of hours used in the four peak periods defined in this study. Exhibit B 1, below, illustrates how each of the above four factors is applied sequentially to a known annual energy value to produce a peak load value, defined as a specific peak period. In the example, the Annual Peak Hour is used.

Exhibit B 1 Illustrative Application of Annual Energy to Peak Period Value Factors

The Annual Peak Hour demand is computed based on the December peak day at 6 pm. The Yukon peak is assumed to occur in December, although the model allows for a January peak, as well.

The following steps are required:

- Step 1: The monthly usage allocation factor for December is applied to the annual energy use to calculate December energy use.
- Step 2: The average weekday in December is calculated based on the formula shown below, which adjusts the average day type use to reflect any difference in typical weekend use versus typical weekday use.
  1/[Days in Month * (5/7 + 2/7 * Weekend Ratio)]
- Step 3: The peak day factor is then applied to the average weekday electric energy use to determine the peak day use (as defined by the Yukon utilities).
- Step 4: The peak hour is then calculated based on allocating the peak day use according to the per unit hourly load factor for a peak winter (December) day, using the percentage of use in that hour versus the daily usage for the December peak day.

It should be noted that the methodology shown in Exhibit B 1 produces aggregate diversified average loads for all customers or end uses in the defined sub sector.

Exhibit B 2 provides a specific numeric example for the calculation of Annual Peak Hour demand (kW). The example presented in Exhibit B 2 is for DHW use in pre-1980 single detached homes, prior to adjustment for fuel share. The example shows how the annual consumption of 2,989 kWh can be converted to a peak demand value for the Annual Peak Hour by the calculation of a corresponding hours-use value.

Exhibit B 2 Sample Hours-Use Calculation for Electric Water Heating

Annual Peak Hour: 6 pm Winter Peak
Annual kWh * Mo. Allocation * 1/(Days in Month * (5/7 + 2/7 * Weekend Ratio)) * Peak Day Factor * Peak Hour % Daily kWh
7 pm Winter Peak = 2,989 [Annual kWh] * 8.72% [Mo. Allocation] * 1/(31 * (5/7 + 2/7 * 1.0 [Dec. Weekend Ratio Calc])) * 1.0 [Dec. Peak Day Factor] * 0.035022 [Peak Hour % Day kWh] = 0.294 kW
Hours-Use Factor = 2,989 [annual kWh] / 0.294 [7 pm Winter Peak] = 10,153 [Annual Peak Hour Hours Use]
This means that any applicable single-family detached annual water heating kWh can be converted to demand at winter peak hour (6 pm) by dividing by 10,153.

For other peak periods, different sets of hours are used, with calculations corresponding to the above steps. The resulting relationship between annual use and peak can be defined in terms of an hours-use factor, the ratio of the annual energy to the peak, for each of the four defined peak periods.

B.2 Segmentation of Residential Dwellings

The Residential sector segmentation used to generate the electric peak load profiles is the same as that used for electric energy use. That is, there is a load profile that corresponds to each combination of dwelling type and end use.

Exhibit B 3 shows the residential dwelling types that were addressed.

Exhibit B 3 Residential Dwelling Types Used for Electric Peak Load Calculations

Dwelling Type (SDH/ Duplex, Farm House, First Nations, Row house, Condo low vs. high-rise, Mobile/Other)
Building Vintage (Pre- vs. Post-1980)
Heating Fuel (Electric vs. Non-electric)

Exhibit B 4 describes the assumptions and data sources for each of the four load profile factors that were used to develop the corresponding hours-use factors. To produce a demand for a combination of sub sector and end use, the corresponding annual energy is divided by the hours-use factor for each of the four peak periods for the applicable load shape. For certain end uses that are assumed to have no usage during the winter months (e.g., cooling) the hours-use values are considered infinite (noted by 1E+15), resulting in virtually zero demand when divided into annual energy.

Exhibit B 4 Residential End Use Load Shape Parameters

Load Shape #	End Use	Monthly Breakdown	Wkend / Wkday Ratio	Peak Day Factor	Hourly Profile
1001	Space Heating – Detached/Duplex, First Nations	10-yr average Whitehorse HDD	1.09 BC Hydro Res. Load Model - SDH[37]	10-yr average Whitehorse HDD	BCH Residential Premise Load Model - SDH
1002	Space Heating – Row Houses	10-yr average Whitehorse HDD	BC Hydro Res. Load Model - Row[38]	10-yr average Whitehorse HDD	BCH Residential Premise Load Model - Row
1003	Central A/C – All	10-yr average Whitehorse CDD	1.00 various studies	10-yr average Whitehorse CDD Ratio	RG&E 1991 Study
1004	Water Heating – All	RG&E 1991 Study	1.00 various studies	1.0 Assumed	RG&E 1991 Study
1005	Cooking – All	Mass. JUMP	Mass JUMP[39, 40]	1.0 Assumed	Mass. JUMP
1006	Refrigerator – All	Mass. JUMP	1.00 various studies	1.0 Assumed	Mass. JUMP
1007	Lighting – All	LILCO Direct Install Program 1991 adj. by DOE[41] Seasonality	LILCO[42]	1.0 Assumed	LILCO Direct Install Program 1991 adj. by DOE Seasonality
1008	Clothes Dryer – All	Mass. JUMP Refrigerator	Mass. JUMP	1.0 Assumed	Mass. JUMP
1009	Clothes Washer – All	LILCO DSM			
1010	Dishwasher – All	LILCO DSM Program Eval 1988-1991	1.00 various studies	1.0 Assumed	ELCAP DOE[43]
1011	General Plug Loads	USDOE Building America 2008 Misc. Electric Loads[6]	1.00 Assumed	1.0 Assumed	USDOE Building America 2008 Misc. Electric Load
1012	Television – All	California Energy Commission			
1013	Room A/C – All	10-yr average Whitehorse CDD	1.00 various studies	10-yr average Whitehorse CDD Ratio	RG&E 1991 Study
1014	Pool Pumps, Hot Tubs	BCH REUS[44] & SCE RAEUS[45]	SCE RAEUS	SCE RAEUS	Hr End 7pm SCE RAEUS

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[37] BC Hydro FY 2005 (April 2004 – March 2005) Residential Load Research data by segment (SDH – Single Family; Row – Row Houses).

[38] BC Hydro FY 2005 (April 2004 – March 2005) Residential Load Research data by segment (SDH – Single Family; Row – Row Houses).

[39] Massachusetts JUMP Update and Analysis (Appliance Monitoring Project), AEIC Northeast Regional Conference and Proceedings; Hartford, CT; September 16, 1988; S. Chiara (ComEnergy) and J. Lopes (AEG).

[40] Massachusetts Joint Utility End Use Monitoring Project Final Report – Final Report; Applied Energy Group, Inc.; Feb 15, 1989.

[41] Building America Research Benchmark Definition – Updated December 20, 2007; USDOE Renewable Energy Laboratory NREL/TP-550-42662; January 2008.

[42] Long Island Lighting Company; DSM Program Evaluations; 1988 – 1991.

[43] Description of Electric Energy Use in Single-Family Residences in the Pacific Northwest (ELCAP), DOE/BP-13795-21, PNNL; ref. in "Building America Research Benchmark Definition"; Jan. 2008.

[44] BC Hydro REUS (Appliance Saturation Study) estimates of saturation of component appliances (outdoor and indoor pools, outdoor hot tubs and indoor Jacuzzis), and SCE RAEUS monthly energy use used to calculate weighted monthly energy use for monthly allocation averages.

Load Shape #	End Use	Monthly Breakdown	Wkend / Wkday Ratio	Peak Day Factor	Hourly Profile
1015	Engine Block Heater	10-yr average Whitehorse HDD < -10HDD	1.00 assumed	10-yr average Whitehorse HDD	Flat, average 7.9 hrs/day for 90 days[46]
1016	Ventilation – Total Commercial	RG&E Total Commercial Ventilation	RG&E Total Commercial Ventilation	RG&E Total Commercial Ventilation	RG&E Total Commercial Ventilation
1017	Outdoor Lighting	Dusk-to-Dawn Model, with Whitehorse sunrise/sunset	1.00 Assumed	1.0 Assumed	Based on Dusk-to-Dawn Model, Whitehorse sunrise/sunset[47]
1018	Holiday Lighting	90% December 10% January	1.00 Assumed	1.0 Assumed	Dusk to Midnight model, similar to base lighting until midnight only

Exhibit B 5 shows the distinct hour-use values developed for each combination of peak period, sector, sub sector and end use employed in this study, as generated from the applicable load shape.

The hours-use value represents the divisor to convert annual energy (e.g., MWH) to that peak period demand. For example, dividing the annual electricity consumed for space heating in single detached houses by the hours-use value for the Annual Peak Hour (i.e., 2,798) will convert annual MWh to demand at the annual system peak hour (6 pm).

Exhibit B 5 Residential Sector Load Shape Hours-Use Values

CODE	Sector Type	SubSector	Region	End Use	End Use Sub	Measure	Hours-use Values		
							Peak1 Annual Peak Hour	Peak2 Evening Peak	Peak3 Morning Peak
1001	Res	SDH	All	Space Heat	All	Base	2,798	2,865	4,130
1002	Res	Row	All	Space Heat	All	Base	2,818	2,850	4,830
1003	Res	All	All	Central A/C	All	Base	1.00E+15	1.00E+15	1.00E+15
1004	Res	All	All	Water Heat	All	Base	11,285	10,114	3,969
1005	Res	All	All	Stove	All	Base	1,479	3,196	4,796
1006	Res	All	All	Refrigerator	All	Base	7,949	8,374	10,525
1007	Res	All	All	Lighting	All	Base	4,137	3,724	9,325
1008	Res	All	All	Dryer	All	Base	3,687	4,519	28,385
1009	Res	All	All	Clothes Washer	All	Base	5,403	5,412	13,836
1010	Res	All	All	Dishwasher	All	Base	5,787	4,208	6,944
1011	Res	All	All	General Plug Loads	All	Base	6,759	6,609	9,012
1012	Res	All	All	Television	All	Base	6,393	6,473	8,764
1013	Res	All	All	Room A/C	All	Base	1.00E+15	1.00E+15	1.00E+15
1014	Res	All	All	Pools and Hot tubs	All	Base	6,542	6,953	7,053
1015	Res	All	All	Engine Block Heaters	All	Base	1,493	1,194	1.00E+15
1016	Res	All	All	Ventilation	All	Base	6,245	6,698	6,824
1017	Res	All	All	Outdoor Lighting	All	Base	4,277	4,602	4,103
1018	Res	All	All	Holiday Lighting	All	Base	271	260	1.00E+15

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[45] Southern California Edison 1988 RAEUS (End Use) Study – Indoor/outdoor Pool Pumps and Electric Spas/Jacuzzis.

[46] Ontario Power Authority – OPA Measures and Assumptions List (prescriptive) as of January 31, 2010; 1450 watts at 7.9 hours/day x 90 days.

[47] Based on Whitehorse sunrise/sunset times, with 5% during daylight hours.

Since YECL does not conduct regular class or end-use load analysis studies, there is no actual total (or dwelling type) end-use load profile upon which to calibrate the load profile models developed for this study. Class load studies have been performed for cost-of-service and rate design purposes, but results were not yet available. End-use data collection has not been performed. Summing all end uses would produce a total residential daily load profile, but the YECL class load profile to which it would be compared would still only be a statistical estimate and not an actual, in the same way that the annual kWh energy sales would be for the calibration of total annual kWh. The best option for calibrating Yukon-specific load profile parameters is the weather-sensitive loads, since that is the most area specific.

Since separately metered space heating end-use load data was not available from YECL, normal weather for the past 10 years was used to determine monthly allocations, and weekend/weekday ratios were developed from similar studies for another Canadian utility.

For peak day factors, analysis of the past 10 years' average vs. peak weather conditions (in heating degree days) for Whitehorse was analyzed to determine typical peak day factors for normal weather, which ranged from about 1.4 to 1.5 for winter months. For non weather-sensitive end uses, a factor of 1.0 was assumed, absent specific load study data.

B.3 Detailed Results

The next three exhibits show peak demand by dwelling type and end use for each of the three peak periods identified for this study. These first three exhibits are followed by twelve more showing the results by supply system.

Note that in each of the exhibits, the end uses are sorted from largest peak demand to smallest peak demand, so they do not appear in the same order in the three exhibits.

Exhibit B 6 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use (MW)*

Dwelling Type	Space heating	Cooking appliances	Indoor lighting	Clothes dryer	Domestic hot water (DHW)	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Refrigerator	Ventilation & circulation
Single Detached Houses	7.36	3.23	1.80	2.04	1.82	1.56	1.30	1.04	0.74	0.62
Apartments	0.87	0.41	0.45	0.23	0.17	0.06	0.30	0.18	0.10	0.19
Attached/Row Houses	0.58	0.29	0.16	0.17	0.19	0.19	0.16	0.13	0.08	0.06
Mobile/Other	0.71	0.31	0.17	0.15	0.20	0.09	0.14	0.11	0.07	0.07
Seasonal & Garage	0.09	0.13	0.18	0.06	0.07	0.14	0.04	0.03	0.02	0.02
Small Grid Housing	0.04	0.08	0.04	0.04	0.04	0.03	0.03	0.02	0.02	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	9.66	4.44	2.81	2.70	2.50	2.08	1.97	1.52	1.03	0.98

Dwelling Type	Holiday lighting	Outdoor lighting	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Single Detached Houses	0.75	0.49	0.47	0.44	0.33	0.28	0.20	0.12	0.12	0.10	24.82
Apartments	0.08	0.05	0.07	0.08	0.07	0.05	0.03	0.02	0.01	0.01	3.41
Attached/Row Houses	0.05	0.04	0.05	0.06	0.04	0.03	0.02	0.01	0.01	0.01	2.33
Mobile/Other	0.05	0.05	0.04	0.05	0.04	0.03	0.02	0.01	0.01	0.01	2.33
Seasonal & Garage	-	0.05	0.01	0.01	0.01	0.01	0.06	0.01	0.00	0.00	0.99
Small Grid Housing	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.44
Sentinel Lighting	-	0.14	-	-	-	-	-	-	-	-	0.14
Grand Total	0.95	0.83	0.65	0.65	0.50	0.41	0.33	0.17	0.15	0.14	34.46

*Results are measured at the customer's point-of-use and do not include line losses. Any differences in totals are due to rounding.

Exhibit B 7 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use (MW)

Dwelling Type	Space heating	Indoor lighting	Domestic hot water (DHW)	Block heaters & car warmers	Clothes dryer	Cooking appliances	Spa heaters and pumps	Computer and peripherals	Holiday lighting	Refrigerator
Single Detached Houses	7.18	2.00	2.03	1.62	1.67	1.50	1.47	1.07	0.78	0.71
Apartments	0.86	0.50	0.19	0.37	0.19	0.19	0.06	0.18	0.08	0.10
Attached/Row Houses	0.58	0.18	0.21	0.20	0.14	0.13	0.18	0.13	0.05	0.07
Mobile/Other	0.69	0.19	0.23	0.18	0.12	0.14	0.08	0.12	0.06	0.06
Seasonal & Garage	0.09	0.20	0.08	0.05	0.05	0.06	0.14	0.03	-	0.02
Small Grid Housing	0.04	0.05	0.05	0.03	0.04	0.04	0.03	0.02	0.02	0.02
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	9.45	3.12	2.79	2.46	2.20	2.05	1.96	1.55	0.99	0.98

Dwelling Type	Ventilation & circulation	Outdoor lighting	Television	Heat tape, propane htrs, circ pumps	Freezer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Single Detached Houses	0.58	0.45	0.44	0.41	0.45	0.28	0.20	0.16	0.12	0.10	23.22
Apartments	0.17	0.04	0.07	0.09	0.06	0.05	0.03	0.02	0.01	0.01	3.28
Attached/Row Houses	0.06	0.04	0.05	0.05	0.05	0.03	0.02	0.01	0.01	0.01	2.22
Mobile/Other	0.07	0.04	0.05	0.04	0.04	0.03	0.02	0.01	0.01	0.01	2.19
Seasonal & Garage	0.02	0.05	0.01	0.01	0.01	0.01	0.07	0.01	0.01	0.00	0.93
Small Grid Housing	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.41
Sentinel Lighting	-	0.13	-	-	-	-	-	-	-	-	0.13
Grand Total	0.92	0.77	0.64	0.62	0.62	0.40	0.34	0.21	0.17	0.14	32.38

Exhibit B 8 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use (MW)

Dwelling Type	Domestic hot water (DHW)	Space heating	Spa heaters and pumps	Cooking appliances	Indoor lighting	Computer and peripherals	Ventilation & circulation	Outdoor lighting	Refrigerator	Freezer
Single Detached Houses	5.18	4.98	1.45	1.00	0.80	0.78	0.57	0.51	0.56	0.35
Apartments	0.49	0.51	0.05	0.13	0.20	0.13	0.17	0.05	0.08	0.05
Mobile/Other	0.57	0.48	0.08	0.09	0.08	0.09	0.07	0.05	0.05	0.03
Attached/Row Houses	0.54	0.34	0.18	0.09	0.07	0.10	0.06	0.04	0.06	0.04
Seasonal & Garage	0.21	0.06	0.13	0.04	0.08	0.02	0.02	0.05	0.02	0.01
Small Grid Housing	0.13	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
Sentinel Lighting	-	-	-	-	-	-	-	0.15	-	-
Grand Total	7.12	6.41	1.93	1.37	1.25	1.14	0.90	0.86	0.78	0.49

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Holiday lighting	Grand Total
Single Detached Houses	0.32	0.27	0.20	0.15	0.10	0.09	0.04	0.00	0.00	0.00	17.35
Apartments	0.06	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	2.02
Mobile/Other	0.04	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.70
Attached/Row Houses	0.04	0.02	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.64
Seasonal & Garage	0.01	0.01	0.01	0.05	0.00	0.01	0.00	0.00	0.00	-	0.73
Small Grid Housing	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.15
Grand Total	0.47	0.35	0.30	0.25	0.13	0.12	0.05	0.00	0.00	0.00	23.91

Exhibit B 9 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use, Hydro Grid Accounts (MW)

Dwelling Type	Space heating	Cooking appliances	Indoor lighting	Clothes dryer	Domestic hot water (DHW)	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Refrigerator	Ventilation & circulation
Single Detached Houses	7.15	3.08	1.72	1.94	1.74	1.49	1.24	0.99	0.71	0.59
Apartments	0.87	0.40	0.44	0.23	0.17	0.06	0.29	0.17	0.10	0.18
Attached/Row Houses	0.57	0.27	0.15	0.16	0.18	0.19	0.15	0.12	0.07	0.06
Mobile/Other	0.68	0.28	0.16	0.14	0.19	0.08	0.13	0.10	0.06	0.06
Seasonal & Garage	0.09	0.12	0.17	0.06	0.07	0.13	0.04	0.03	0.02	0.02
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	9.34	4.14	2.63	2.53	2.34	1.94	1.85	1.42	0.96	0.92

Dwelling Type	Holiday lighting	Outdoor lighting	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Single Detached Houses	0.71	0.46	0.45	0.42	0.31	0.27	0.19	0.11	0.11	0.10	23.77
Apartments	0.08	0.05	0.06	0.07	0.07	0.05	0.02	0.01	0.01	0.01	3.36
Attached/Row Houses	0.05	0.04	0.05	0.05	0.04	0.03	0.02	0.01	0.01	0.01	2.23
Mobile/Other	0.05	0.04	0.04	0.04	0.03	0.03	0.02	0.01	0.01	0.01	2.15
Seasonal & Garage	-	0.05	0.01	0.01	0.01	0.01	0.06	0.01	0.00	0.00	0.91
Sentinel Lighting	-	0.12	-	-	-	-	-	-	-	-	0.12
Grand Total	0.89	0.76	0.61	0.60	0.47	0.38	0.31	0.16	0.14	0.13	32.54

Exhibit B 10 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use, Hydro Grid Accounts (MW)

Dwelling Type	Space heating	Indoor lighting	Domestic hot water (DHW)	Block heaters & car warmers	Clothes dryer	Cooking appliances	Spa heaters and pumps	Computer and peripherals	Holiday lighting	Refrigerator
Single Detached Houses	6.98	1.91	1.94	1.54	1.58	1.42	1.40	1.01	0.74	0.67
Apartments	0.86	0.49	0.19	0.37	0.19	0.18	0.05	0.18	0.08	0.10
Attached/Row Houses	0.56	0.17	0.20	0.19	0.13	0.13	0.17	0.13	0.05	0.07
Mobile/Other	0.66	0.17	0.21	0.16	0.11	0.13	0.08	0.11	0.05	0.06
Seasonal & Garage	0.08	0.19	0.07	0.05	0.05	0.05	0.12	0.03	-	0.02
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	9.14	2.93	2.61	2.32	2.06	1.92	1.83	1.45	0.92	0.92

Dwelling Type	Ventilation & circulation	Outdoor lighting	Television	Heat tape, propane htrs, circ pumps	Freezer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Single Detached Houses	0.55	0.43	0.42	0.39	0.42	0.26	0.19	0.16	0.11	0.10	22.24
Apartments	0.17	0.04	0.07	0.09	0.06	0.05	0.03	0.02	0.01	0.01	3.23
Attached/Row Houses	0.06	0.04	0.05	0.05	0.04	0.03	0.02	0.01	0.01	0.01	2.12
Mobile/Other	0.06	0.04	0.04	0.04	0.04	0.03	0.02	0.01	0.01	0.01	2.03
Seasonal & Garage	0.02	0.04	0.01	0.01	0.01	0.01	0.06	0.00	0.01	0.00	0.86
Sentinel Lighting	-	0.11	-	-	-	-	-	-	-	-	0.11
Grand Total	0.86	0.70	0.60	0.58	0.58	0.38	0.32	0.20	0.16	0.13	30.59

Exhibit B 11 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use, Hydro Grid Accounts (MW)

Dwelling Type	Domestic hot water (DHW)	Space heating	Spa heaters and pumps	Cooking appliances	Indoor lighting	Computer and peripherals	Ventilation & circulation	Outdoor lighting	Refrigerator	Freezer
Single Detached Houses	4.94	4.84	1.38	0.95	0.76	0.74	0.54	0.48	0.53	0.34
Apartments	0.48	0.51	0.05	0.12	0.19	0.13	0.17	0.05	0.08	0.05
Mobile/Other	0.53	0.46	0.07	0.09	0.07	0.08	0.06	0.04	0.05	0.03
Attached/Row Houses	0.52	0.33	0.17	0.08	0.07	0.09	0.06	0.04	0.05	0.03
Seasonal & Garage	0.19	0.06	0.12	0.04	0.07	0.02	0.02	0.05	0.02	0.01
Sentinel Lighting	-	-	-	-	-	-	-	0.13	-	-
Grand Total	6.65	6.19	1.80	1.28	1.17	1.07	0.84	0.79	0.73	0.46

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Holiday lighting	Grand Total
Single Detached Houses	0.31	0.25	0.19	0.14	0.09	0.08	0.04	0.00	0.00	0.00	16.62
Apartments	0.05	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	1.99
Mobile/Other	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.57
Attached/Row Houses	0.04	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.56
Seasonal & Garage	0.01	0.01	0.01	0.05	0.00	0.01	0.00	0.00	0.00	-	0.67
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.13
Grand Total	0.44	0.33	0.28	0.23	0.12	0.12	0.05	0.00	0.00	0.00	22.54

Exhibit B 12 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use, Large Diesel Accounts (MW)

Dwelling Type	Space heating	Cooking appliances	Clothes dryer	Indoor lighting	Domestic hot water (DHW)	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Ventilation & circulation	Refrigerator
Single Detached Houses	0.21	0.15	0.10	0.09	0.09	0.08	0.06	0.05	0.03	0.04
Mobile/Other	0.04	0.03	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01
Attached/Row Houses	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
Apartments	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Seasonal & Garage	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	0.27	0.21	0.13	0.13	0.12	0.10	0.09	0.07	0.05	0.05

Dwelling Type	Outdoor lighting	Holiday lighting	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Single Detached Houses	0.02	0.04	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	1.05
Mobile/Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
Attached/Row Houses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Apartments	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Seasonal & Garage	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Sentinel Lighting	0.01	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	1.45

Exhibit B 13 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use, Large Diesel Accounts (MW)

Dwelling Type	Space heating	Indoor lighting	Domestic hot water (DHW)	Block heaters & car warmers	Clothes dryer	Cooking appliances	Spa heaters and pumps	Computer and peripherals	Refrigerator	Ventilation & circulation
Single Detached Houses	0.20	0.10	0.09	0.08	0.08	0.07	0.07	0.05	0.03	0.03
Mobile/Other	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Attached/Row Houses	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00
Apartments	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seasonal & Garage	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	0.27	0.14	0.13	0.11	0.10	0.10	0.09	0.07	0.05	0.05

Dwelling Type	Holiday lighting	Outdoor lighting	Television	Freezer	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Single Detached Houses	0.04	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.98
Mobile/Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16
Attached/Row Houses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Apartments	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Seasonal & Garage	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Sentinel Lighting	-	0.01	-	-	-	-	-	-	-	-	0.01
Grand Total	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.01	1.35

Exhibit B 14 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use, Large Diesel Accounts (MW)

Dwelling Type	Domestic hot water (DHW)	Space heating	Spa heaters and pumps	Cooking appliances	Indoor lighting	Computer and peripherals	Outdoor lighting	Ventilation & circulation	Refrigerator	Freezer
Single Detached Houses	0.24	0.14	0.07	0.05	0.04	0.04	0.02	0.03	0.03	0.02
Mobile/Other	0.05	0.02	0.01	0.01	0.01	0.01	0.00	0.01	0.00	0.00
Attached/Row Houses	0.03	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seasonal & Garage	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apartments	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sentinel Lighting	-	-	-	-	-	-	0.01	-	-	-
Grand Total	0.34	0.18	0.09	0.06	0.06	0.05	0.05	0.05	0.04	0.02

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Holiday lighting	Grand Total
Single Detached Houses	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.73
Mobile/Other	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13
Attached/Row Houses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.04
Apartments	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	1.02

Exhibit B 15 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use, Small Diesel Accounts (MW)

Dwelling Type	Cooking appliances	Indoor lighting	Domestic hot water (DHW)	Clothes dryer	Space heating	Spa heaters and pumps	Outdoor lighting	Block heaters & car warmers	Computer and peripherals	Holiday lighting
Small Grid Housing	0.04	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
Sentinel Lighting	-	-	-	-	-	-	0.01	-	-	-
Grand Total	0.05	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01

Dwelling Type	Refrigerator	Ventilation & circulation	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Small Grid Housing	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.25
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.27

Exhibit B 16 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use, Small Diesel Accounts (MW)

Dwelling Type	Indoor lighting	Domestic hot water (DHW)	Space heating	Cooking appliances	Clothes dryer	Spa heaters and pumps	Block heaters & car warmers	Outdoor lighting	Computer and peripherals	Holiday lighting
Small Grid Housing	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
Sentinel Lighting	-	-	-	-	-	-	-	0.01	-	-
Grand Total	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01

Dwelling Type	Refrigerator	Ventilation & circulation	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Small Grid Housing	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.23
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.25

Exhibit B 17 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use, Small Diesel Accounts (MW)

Dwelling Type	Domestic hot water (DHW)	Spa heaters and pumps	Space heating	Outdoor lighting	Cooking appliances	Indoor lighting	Computer and peripherals	Refrigerator	Ventilation & circulation	Freezer
Small Grid Housing	0.07	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sentinel Lighting	-	-	-	0.01	-	-	-	-	-	-
Grand Total	0.07	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Holiday lighting	Grand Total
Small Grid Housing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.01
Grand Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20

Exhibit B 18 Residential Sector Base Year (2010) Period 1, Peak Hour Demand, by Dwelling Type and End Use, Old Crow Accounts (MW)

Dwelling Type	Cooking appliances	Indoor lighting	Domestic hot water (DHW)	Clothes dryer	Space heating	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Holiday lighting	Refrigerator
Small Grid Housing	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	-	0.00
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	0.04	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01

Dwelling Type	Outdoor lighting	Ventilation & circulation	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Grand Total
Small Grid Housing	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20
Seasonal & Garage	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.01
Sentinel Lighting	0.00	-	-	-	-	-	-	-	-	-	0.00
Grand Total	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21

Exhibit B 19 Residential Sector Base Year (2010) Period 2, Annual System Peak, by Dwelling Type and End Use, Old Crow Accounts (MW)

Dwelling Type	Indoor lighting	Domestic hot water (DHW)	Space heating	Cooking appliances	Clothes dryer	Spa heaters and pumps	Block heaters & car warmers	Computer and peripherals	Holiday lighting	Refrigerator
Small Grid Housing	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.01
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	-	0.00
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-
Grand Total	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01

Dwelling Type	Outdoor lighting	Ventilation & circulation	Freezer	Television	Heat tape, propane htrs, circ pumps	Set-top boxes	Small appliance & other	Dishwasher	Home entertainment electronics	Clothes washer	Grand Total
Small Grid Housing	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18
Seasonal & Garage	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	0.00	0.01
Sentinel Lighting	0.00	-	-	-	-	-	-	-	-	-	0.00
Grand Total	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19

Exhibit B 20 Residential Sector Base Year (F2010) Period 3, Annual Morning Peak, by Dwelling Type and End Use, Old Crow Accounts (MW)

Dwelling Type	Domestic hot water (DHW)	Spa heaters and pumps	Space heating	Cooking appliances	Indoor lighting	Computer and peripherals	Outdoor lighting	Refrigerator	Ventilation & circulation	Freezer
Small Grid Housing	0.06	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sentinel Lighting	-	-	-	-	-	-	0.00	-	-	-
Grand Total	0.06	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00

Dwelling Type	Television	Clothes dryer	Set-top boxes	Small appliance & other	Home entertainment electronics	Dishwasher	Clothes washer	Block heaters & car warmers	Heat tape, propane htrs, circ pumps	Holiday lighting	Grand Total
Small Grid Housing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Seasonal & Garage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-	0.01
Sentinel Lighting	-	-	-	-	-	-	-	-	-	-	0.00
Grand Total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15

Appendix C Background-Section 5: Reference Case Electricity Use

Introduction

Appendix C provides additional detailed information related to each of the major steps employed to generate the profile of Residential sector Reference Case electricity use. The major steps involved are:

- Step 1: Estimate net space heating and cooling loads for each new dwelling type
- Step 2: Estimate naturally-occurring changes in net space heating and cooling loads for existing dwelling types
- Step 3: Estimate naturally-occurring changes in annual electricity use for the evolving stock of major residential appliances
- Step 4: Estimate future appliance saturation trends for each dwelling type
- Step 5: Estimate changes in electricity share for each appliance, by dwelling type
- Step 6: Estimate the growth in number of residential dwellings, by type.

C.1 Step 1: Estimation of Net Space Heating and Cooling Loads—New Dwellings

The first task in building the Reference Case involved the development of estimates of the net space heating loads for new dwellings to be built over the study period. As was the case with the existing building stock, the study relied on several sources to prepare these estimates, including:

- Estimated electricity consumption per dwelling from the Yukon load forecast
- Consultation with housing experts at Yukon Housing Corporation
- Review of experience in other jurisdictions.

Based on consideration of the best available data from the above sources, this study assumes that the net space heating loads in new dwellings are likely to decrease slightly compared to existing dwellings. This conclusion recognizes that while thermal efficiencies are improving in new dwellings, they are being partially offset by changing construction practices.

Examples of these offsetting trends include:

- Overall, window, wall and roofing thermal efficiency levels have increased in new residential buildings and air leakage rates have been reduced by more than 40% compared to typical existing dwellings
- The amount of window area in new houses has increased by up to 20% compared to typical existing homes
- The new stock tends to have floor areas that are slightly larger, on average, than existing dwellings, though this trend has levelled off recently
- Buildings also feature an increase in exterior wall surface area of between 5%-20%. This reflects both the increased floor area and a tendency for homes to include architectural features with more corners and details that diverge from the standard rectangular shapes.

Exhibit C 1 summarizes the resulting new net space heating and cooling loads.

Exhibit C 1 New Residential Units—Net Space Heating Loads[48] by Dwelling Type, (kWh/yr.)

Dwelling Types	Tertiary Heating Load (kWh/yr.)			
	Hydro Grid	Large Diesel	Small Diesel	Old Crow
1980 & newer non-electrically heated single detached homes	19,922	19,270	-	-
1980 & newer electrically heated single detached homes	13,284	-	-	-
1980 & newer non-electrically heated attached/row housing	12,724	12,308	-	-
1980 & newer electrically heated attached/row housing	7,263	-	-	-
Non-electrically heated apartment units	10,380	8,535	-	-
Non-electrically heated apartment common areas	25,291	29,287	-	-
Electrically heated apartment units	6,021	-	-	-
Electrically heated apartment common areas	14,669	-	-	-
Non-electrically heated mobile/other	15,062	22,270	-	-
Electrically heated mobile/other	9,287	-	-	-
Small diesel grid housing	-	-	15,693	17,399
Seasonal housing	1,367	1,435	1,065	1,137
Residential garages	9,806	6,962	3,922	9,806

C.1.1 Development of Thermal Archetypes – New Stock

Although the study assumes that the net space heating loads decrease only slightly for new dwellings, the physical and thermal specifications of the new dwellings differ from the existing dwellings. Thus, as in the Base Year discussion, a thermal archetype for each of the major new dwelling types was developed using HOT2000.

For the new housing stock, archetypes were created for the two primary dwelling types in each service region: single-family detached and attached. A brief description of each housing archetype is provided below.

Single detached houses

A typical new single-family detached dwelling can be defined as a single-story bungalow of approximately 170 m^2 (1,800 ft^2), including a finished basement. This home has approximately 19.0 m^2 (205 ft^2) of window area, typically low-e, argon-filled, triple-glazed window units with vinyl frames. Walls are represented by RSI-4.9 (R-28) insulation values, ceilings RSI-8.8 (R-50) and the basement is insulated to a value of RSI-4.9 (R-28) all the way to the basement floor. The houses are reasonably airtight with about 1.5 ACH@50Pa (air changes per hour at 50 Pascal depressurization).

Attached Dwellings

A typical new attached dwelling can be defined as a one-story end unit of approximately 125 m^2 (1,350 ft^2), including a finished basement. This home has 11.5 m^2 (125 ft^2) of windows, typically low-e, argon-filled, triple-glazed window units with vinyl frames. Walls are represented by RSI-RSI-4.9 (R-28) insulation values, ceilings RSI-8.8 (R-50) and the basement is insulated to a value of RSI-4.9 (R-28) all the way to the basement floor. The houses are reasonably airtight, with an air change rate of about 1.5 ACH@50Pa.

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[48] Net space heating load is the space heating load of a building that must be met by the space heating system over a full year. This is equal to the total heat loss through the building envelope minus solar and internal gains. Values shown for non-electrically heated dwellings are shown in kilowatt hours for format consistency.

C.2 Step 2: Natural Changes to Space Heating Loads – Existing Dwellings

In addition to new dwellings, space heating loads in existing dwellings are also expected to change over the study period. However, no specific data are available and, as outlined in the preceding discussion of new dwellings, contrary trends[49] are occurring.

Examples of trends that tend to decrease the net space heating loads include:

- Insulation and other improvements that occur when renovation projects are undertaken
- Replacement of old windows with new models that provide comfort and aesthetic benefits as well as improved energy efficiency
- Installation of more efficient thermostatic controls.

Examples of trends that tend to increase net space heating loads include:

- Enlargement of houses with additions
- Reductions in internal gains due to more efficient appliances and lights.

Dwellings that undergo a major energy retrofit to the building shell are moved from the existing dwelling category into renovated dwellings. On average, these projects are assumed to include two building envelope retrofits (though they may not all happen in the same month), such as replacement of half the windows and the addition of insulation to the attic. In past projects, window replacement has been used as an indicator of the percentage of dwellings being renovated. Window sales are typically divided roughly evenly between installation in new homes and replacement in existing homes. A typical window replacement project involves approximately half the windows in the dwelling. Therefore, the rate of renovation is approximately double the rate of new construction.

Trial energy simulation runs were undertaken in HOT2000, assuming a variety of combinations of retrofit measures. The results varied widely, from a 2% to 15% reduction in space heat and cooling loads, depending on assumptions related to the number of windows replaced, or the part of the house being insulated. These decreases will be partly or wholly offset in those renovation jobs that also increase the floor area of the dwelling.

In the absence of more comprehensive data, this study assumes that a renovation to a home built after 1980 would experience a net reduction in space heating load of 3%. An older home (n which it was assumed more likely there would be an addition to the floor area) would experience a net reduction in space heating load of 2%.

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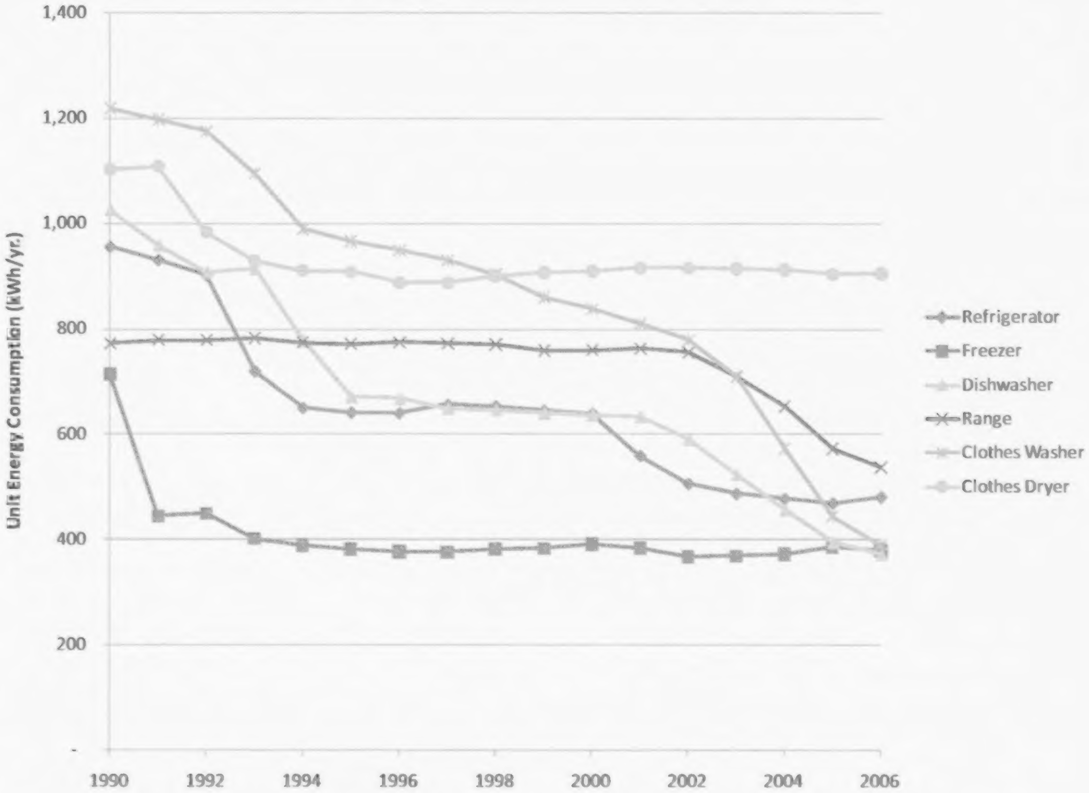
[49] Replacement of the heating equipment itself is not one of these factors because it does not actually change the net heating load.

C.3 Step 3: Natural Changes to Electric Appliance UECs

This section identifies the annual unit electricity consumption (UEC) for the major household appliances and equipment for both "stock in place" and new sales for the period 2010 to 2030.

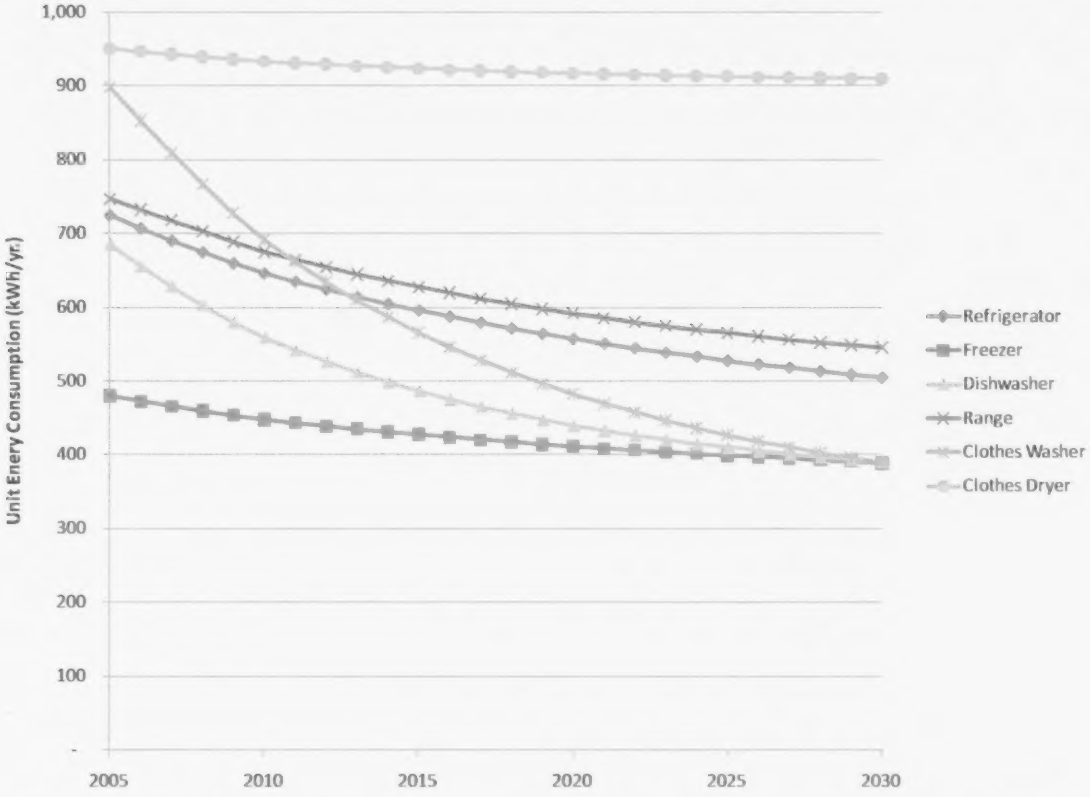
Exhibit C 2 shows Canadian trend information for the new sales of white goods for the period 1990 to 2006. Exhibit C 3 incorporates the average consumption data for new sales into ICF Marbek's appliance stock model to develop forecasts for average consumption of the white goods appliances throughout the study period.

Exhibit C 2 Canadian White Goods, UECs for New Sales



Source: NRCan, *Energy Consumption of Major Household Appliances Shipped in Canada: Trends for 1990-2006*.

Exhibit C 3 Canadian White Goods, UECs for Existing Stock



Source: Original NRCan UEC data for new sales (see source note for previous exhibit), incorporated into Marbek's appliance stock model.

As shown in Exhibit C 3, the annual UEC for most major household white good type appliances in existing stock is expected to decline steadily until nearly 2020, due to stock turnover and to continuing improvements in new stock. Future regulations or innovations may bring additional improvements in the white goods in the later years of the study period, but no assumptions have been made to that effect. Instead, the consumption of the different appliances is permitted to level off.

Further discussion of the modelled assumptions applied to each of the major appliances follows.

Cooking

A UEC, which includes both ranges and microwave ovens, of 668 kWh/yr. is assumed in the Base Year, declining to 540 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of cooking appliances), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a cooking UEC of 585 kWh/yr. on average, declining to 540 kWh/yr. by 2030.

Refrigerator

A UEC of 614 kWh/yr. is assumed in the Base Year, declining to 479 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore average size of refrigerators), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a refrigerator UEC of 529 kWh/yr. on average, declining to 479 kWh/yr. by 2030.

Freezer

A UEC of 443 kWh/yr. is assumed in the Base Year, declining to 365 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore average size of freezers), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a freezer UEC of 407 kWh/yr. on average, declining to 365 kWh/yr. by 2030.

Dishwasher

A UEC of 108 kWh/yr. is assumed in the Base Year, declining to 75 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of dishwashers), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a dishwasher UEC of 85 kWh/yr. on average, declining to 75 kWh/yr. by 2030.

The values shown are for mechanical energy only. Mechanical energy is assumed to be approximately 19% of the values reflected in Exhibit C3. Hot water use is included with the DHW UEC.

Clothes Washer

A UEC of 61 kWh/yr. is assumed in the Base Year, declining to 34 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of clothes washers), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a clothes washer UEC of 42 kWh/yr. on average, declining to 34 kWh/yr. by 2030.

The values shown are for mechanical energy only. Mechanical energy is assumed to be approximately 9% of the values reflected in Exhibit C3. Hot water use is included with the DHW UEC.

Clothes Dryer

A UEC of 924 kWh/yr. is assumed in the Base Year, declining to 901 kWh/yr. in the final milestone year. The variation by dwelling type, mainly due to differences in occupancy (and therefore use of clothes dryers), follows the pattern shown in Exhibit A 2. In new dwellings, the appliances are assumed to be approximately 10 years newer than in existing dwellings. New homes built right after the Base Year are assumed to have a dryer UEC of 908 kWh/yr. on average, declining to 901 kWh/yr. by 2030.

Ventilation

Ventilation energy in existing stock is assumed to remain constant. This assumption recognizes that there are a number of competing trends that remain unresolved at this time. On the one hand, there is a trend towards manufacturers' use of larger fan motors (1/2-HP versus 1/3-HP) in new furnaces. This means that furnaces replaced in the study period may have a larger furnace fan motor. However, the trend towards larger fan motors is at least partially offset by efficiency improvements. For example, an earlier study for the Canadian Electricity Association (CEA) noted that improved fan design, combined with the use of permanent split capacitor fan motors, had improved furnace fan efficiency by between 13% and 19%.[50]

In new stock, average ventilation energy was assumed to increase by nearly 40%, from the current average of approximately 573 kWh/yr. (including furnace fans, other fans such as exhaust fans in the kitchen, and pumps in boiler systems) to approximately 787 kWh/yr. This value was based on the HOT2000 modeling of newer homes with the furnace fan operating continuously. According to previous studies in other jurisdictions, occupants of newer dwellings are more likely to run their furnace blower fan continuously.

Domestic Hot Water

Exhibit C 4 summarizes the DHW UECs by end use for new dwellings. A comparison with the values presented previously for existing dwellings (see Appendix A) shows a significant reduction for hot water use in clothes washing, with slightly more modest changes for personal consumption.

DHW electricity for new and existing appliances is obtained from NRCan, as discussed above (see Exhibit C 3). For existing and retrofitted buildings, the DHW UEC is assumed to decrease as clothes washers are replaced in the appliance stock, but is otherwise assumed to be constant. The UEC for DHW in new buildings is assumed to be constant.

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[50] Phillips, B. *Blower Efficiency in Domestic Heating Systems*, CEA Report No. 9202-U-921, 1995 and *Optimizing Heat and Air Distribution Systems when Retrofitting Houses with Energy Efficient Equipment*, Canada Mortgage and Housing Corporation, 2002. Ventilation UECs will be higher in dwellings that have air conditioning and/or continuous ventilation.

Exhibit C 4 Distribution of DHW Electricity Use by End Use in New Stock, (kWh/yr.)

DHW Sub End Uses	Electricity per Sub End Use (kWh/yr.)	Electricity per Sub End Use (%)
Clothes Washer	356	13%
Showers	690	26%
Faucets	493	18%
Baths	128	5%
Dishwasher	315	12%
Leaks	192	7%
Tank (Standby) Losses	256	10%
Pipe Losses	256	10%
Total	2,687	100%

Indoor Lighting

The lighting UEC was assumed to decrease as incandescent lamps are phased out and replaced by compact fluorescent lamps. It is assumed that approximately 50% of the remaining incandescent lamps would be replaced by the end of the study period if there was no utility involvement in DSM programming or revision of efficiency standards. Exhibit C 5 shows the assumed lighting counts, average wattage, and hours of use per year used to develop estimates of the overall indoor lighting energy consumption for different dwelling types in 2030.

Exhibit C 5 Indoor Lighting by Dwelling Type, 2030

Dwelling Types	Incandescent Lamps	CFL	Linear Fluorescent Tubes	Halogen Lamps	
SDH	11	28	6	3	(lamps)
Attached	8	21	2	2	(lamps)
Apartment	6	15	1	1	(lamps)
Average Wattage	60	15	48	50	(watts)
Average Hours/Year	500	500	500	500	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	330	210	144	75	759
Attached	240	158	48	50	496
Apartment	180	113	24	25	342

Outdoor Lighting

The lighting UEC was assumed to decrease as incandescent lamps are phased out and replaced by compact fluorescent lamps. It is assumed that approximately 50% of the remaining incandescent lamps would be replaced by the end of the study period if there was no utility involvement in DSM programming or revision of efficiency standards. Exhibit C 6 shows the assumed lighting counts, average wattage, and hours of use per year used to develop estimates of the overall outdoor lighting energy consumption for different dwelling types in 2030.

Exhibit C 6 Outdoor Lighting by Dwelling Type, 2030

Dwelling Types	Incandescent Lamps	Compact Fluorescent Lamps (long hours)	Compact Fluorescent Lamps (short hours)	Linear Fluorescent Tubes	
SDH	2	2	2	1	(lamps)
Attached	1	1	2	0	(lamps)
Apartment	0	0	1	0	(lamps)
Average Wattage	60	15	15	48	(watts)
Average Hours/Year	900	1800	900	365	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	108	54	27	18	207
Attached	54	27	27	0	108
Apartment	0	0	14	0	14

Holiday Lighting

The holiday lighting UEC was assumed to decrease as incandescent strings are phased out and replaced by LED strings. This transition is assumed to be complete by the end of the study period. Exhibit C 7 shows the assumed lighting counts, average wattage, and hours of use per year used to develop estimates of the overall holiday lighting energy consumption for different dwelling types in 2030.

Exhibit C 7 Holiday Lighting by Dwelling Type, 2030

Dwelling Types	Indoor Incandescent Holiday Strings	Indoor LED Holiday Strings	Outdoor Incandescent Holiday Strings	Outdoor LED Holiday Strings	
SDH	0	11	0	8	(lamps)
Attached	0	6	0	5	(lamps)
Apartment	0	3	0	0	(lamps)
Average Wattage	60	1	60	1	(watts)
Average Hours/Year	95	95	125	125	(hr/yr.)
Total Base Year Energy Use (kWh/yr.)					Total
SDH	0	1	0	1	2
Attached	0	1	0	1	1
Apartment	0	0	0	0	0

Televisions

The North American television industry has announced its commitment to convert all analog television to digital broadcasting within the next five years. The transition is occurring August 31, 2011, in the large southern television markets, but will take longer in the North. These broadcast changes are occurring at a time when television technology and programming options are also rapidly changing. Some television technology changes, such as the introduction of liquid crystal display (LCD) and plasma models, may also have significant impacts on household electricity consumption. It is also possible that these changes will result in an increased rate of turnover in the current stock of televisions to models that are better able to take advantage of the high definition (HD) digital signal.

LCD is now the dominant television technology. Although LCD screens typically use less electricity per square inch of screen, consumers typically choose screens that are larger when purchasing an LCD screen compared to cathode ray tube screens (CRTs). When CRTs predominated, the most popular size was 27" but consumers are now more likely to buy a 40" widescreen TV, or even larger. This trend has the effect of reducing the electricity advantage that would be gained from a direct switch to the new LCD technology.

In addition to the increase in screen size, HD television models typically consume more power than equivalent standard definition televisions for all technology types. Since the trend with televisions is towards HD sets with greater resolution, television unit electricity use is expected to increase in the future.

In the long term, ENERGY STAR® and improved energy-efficiency standards for electronics will start to bring down the average electricity use per television, even in the absence of new DSM programs in Yukon. The effects of these improvements will likely be masked by the effects of increasing television size and resolution until after 2020.

In light of these changes, UECs for televisions are assumed to increase from 178 kWh/yr. to 210 kWh/yr. by 2020 and then begin to slowly decline, reaching 207 kWh/yr. by 2030. These assumptions draw on both a 2006 Marbek study, *Technology and Market Profile: Consumer Electronics*,[51] and subsequent work for the Ontario Power Authority in 2009.

Television Peripherals

One implication of the pending changes towards digital television broadcasting is that new signal adaptors, commonly referred to as set-top boxes (STBs), will need to be added to nearly two-thirds of Canadian households to receive a television signal.

Industry representatives estimate that each Canadian subscriber household has, on average, 1.5 set-top boxes.[52] They also note that the trend is towards a greater number of STBs per household and, by 2010, the industry estimates that the average will have increased to approximately two STBs per subscriber household. This is further discussed in the saturation section of this appendix (Section C.4).

When complete, the switch to digital broadcasting is expected to increase national STB electricity consumption by up to four times its current level due to the added requirement for STBs among those televisions currently operating on analog cable or over-the-air broadcast signals. Moreover, within these STBs, the most significant trend is towards greater functionality, which is directly associated with further increases in unit electricity consumption.

At the same time, ENERGY STAR® and improved energy-efficiency standards for electronics will begin to affect STBs. Currently, many of these products consume a substantial fraction of their electricity when no one is watching the television. Standards that specify maximum consumption in standby mode will therefore make a dramatic difference in the UEC for these devices.

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[51] Marbek Resource Consultants. Technology and Market Profile: Consumer Electronics, September 2006.

[52] Ibid.

In light of these changes, UECs for television peripherals are assumed to decrease from 225 kWh/yr. to 172 kWh/yr. over the study period.[53] The decrease is more than offset by the increasing saturation, as discussed in Section C.4.

Computers and Peripherals

Electricity consumption for personal computers is expected to decrease modestly, as monitors move to more energy-efficient flat screen technology and ENERGY STAR® increasingly predominates. This is somewhat counteracted by a growing preference for larger screens, a trend towards longer operating hours both in full operating mode and in idle mode, and the increasing numbers of peripherals. The growth in the number of computers per household is discussed in the saturation section of this appendix (Section C.4).

UECs for personal computers and their peripherals are assumed to decrease from 394 kWh/yr. to 384 kWh/yr. over the study period.

Spas

No increase in the size or heating load of spas has been assumed. In a previous Marbek study for the OPA in 2009, assumptions were developed on the trend towards the use of heat pumps to heat pools and spas. By 2030, the electric resistance heaters are assumed to be completely phased out, even in the absence of new DSM programs in Yukon.

The analysis also assumes that high-efficiency pumps will gradually become more popular in the market, without new DSM intervention, reaching a penetration of 60% by 2030.

UECs for spas, including both the electric heating units (resistance or heat pump) and the pumps, are expected to decline from 8,164 kWh/yr. in 2010 to 3,171 kWh/yr. in 2030.

Home Entertainment Electronics

As functionality increases, other entertainment devices, such as computer games and music systems are becoming more powerful. For example, the new PlayStation 3 games console uses 360 Watts compared to its predecessor, which uses only 45 Watts. One of the selling features of the Nintendo Wii and other next generation products is that they can be left on-line for 24 hours a day.

UECs for both the home entertainment electronics category and the small appliances and other category are likely to increase over the study period. UECs for home entertainment electronics are assumed to increase from 106 kWh/yr. to 1,074 kWh/yr. over the study period.

Block Heaters and Car Warmers

No change was assumed in the consumption of block heaters and car warmers over the study period, in the absence of new utility DSM initiatives.

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[53] Ibid.

Heat Tape, Propane Heaters, and Circulation Pumps

No change was assumed in the consumption of heat tape, propane heaters and circulation pumps over the study period, in the absence of new utility DSM initiatives.

Small Appliances and Other

The UECs for the small appliances and other categories increase over the study period in anticipation of new end uses, but there is considerable uncertainty in the amount of this increase.

Based on the changes observed in previous studies, new end uses are constantly emerging, some of which are substantial consumers of electricity. One example is electric vehicle charging. Electric cars and plug-in hybrids could achieve substantial penetration by the end of the study period; charging of a typical electric vehicle would require approximately 7,000 kWh/yr.[54]

The UEC for this category is assumed to increase from 186 kWh/yr. to 1,895 kWh/yr. over the study period. The growth rate in this end use was adjusted to improve the calibration between the model and the Yukon load forecast. Because there is so much uncertainty in the emergence of new "other" end uses and considerably more knowledge of trends in other end uses, this miscellaneous category was used to increase the consumption per account to match the forecast. The forecast changes in consumption per house vary among the four different supply systems. A growth rate of over 12% per year was applied to Small Appliances and Other in order to match the forecast increase in overall consumption per house on the hydro grid. For accounts on large and small diesel systems and the Old Crow system, the growth rates used for Small Appliances and Other were 9%, 4.5%, and 6%, respectively.

C.4 Step 4: Appliance Saturation Trends

To develop estimates of the future saturation of residential equipment, references from Yukon and previous studies in other jurisdictions were reviewed along with data on trends in the increasing use of entertainment-based electronics.

We have applied the growth rates from these sources to estimate saturations to the end of the study period. Increases in the numbers of set-top boxes drew on Marbek's 2006 study.[55] The results are shown in Exhibit C 8.

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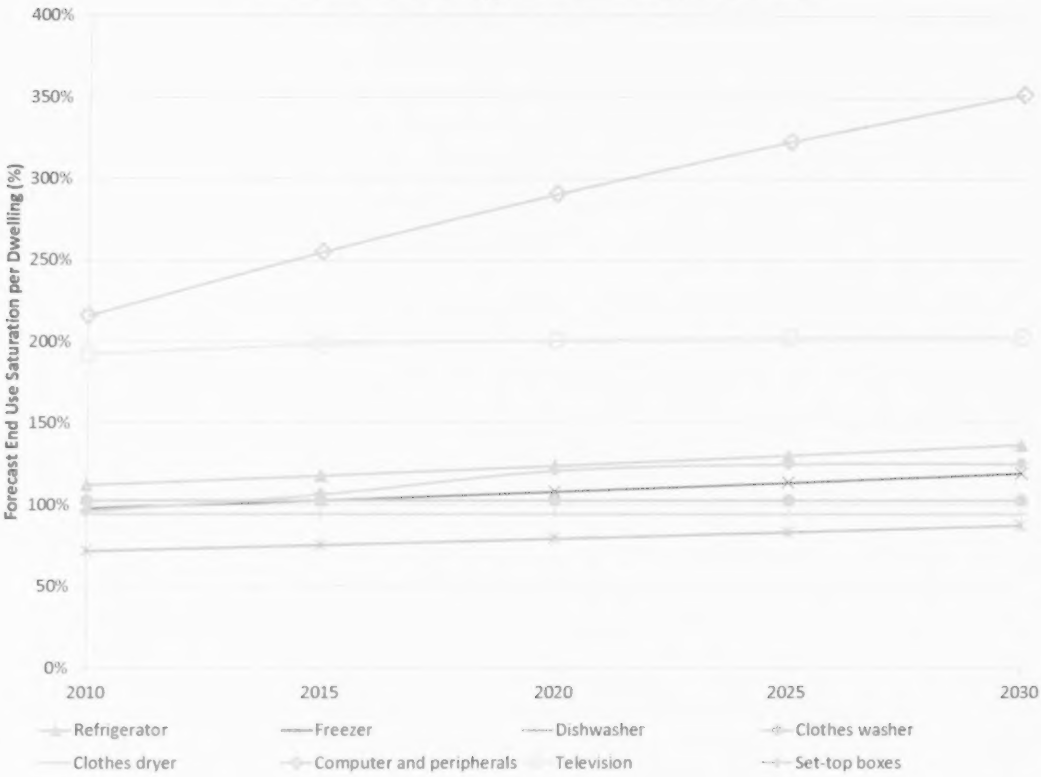
[54] California EPA, Air Resources Board. *Fact Sheet: Battery Electric Vehicles*, Sacramento, CA, 2003, http://www.arb.ca.gov/msprog/zevprog/factsheets/clean_vehicle_incentives.pdf.

[55] Op. cit. *Technology and Market Profile: Consumer Electronics*.

Exhibit C 8 Trends in Appliance Saturation, 2010 to 2030



All of the end-use appliances shown in Exhibit C 8 are forecast to increase in saturation per household. For the white goods end uses, this results in a relatively stable overall consumption per household because the increase in saturation is approximately cancelled out by the decrease in UEC that is expected to occur over the same period. For the three electronics end uses shown in the exhibit, the overall consumption is expected to rise during the period, as increases in saturation will likely have a larger effect than improvements in efficiency.

C.5 Step 5: Fuel Shares

No changes in the fuel shares for any end uses are assumed over the study period.

C.6 Step 6: Estimate Growth in Dwellings, by Type

This step involved the development and application of estimated levels of growth in each dwelling type over the study period.

YEC provided the forecast growth dwelling units as annual percentages for each supply system. The same growth rates were used for all of the dwelling types connected with a given supply system, with one key exception. Where a dwelling type was segmented by vintage, all the growth was applied to the newest vintage.

Exhibit C 9 presents a summary of the resulting percentage stock growth, by year and dwelling type, for Yukon as a whole.

Exhibit C 9 Residential Stock Growth Rates, 2010 to 2030

Dwelling Types	Annualized Stock Growth Rates by Period			
	2010-2015	2015-2020	2020-2025	2025-2030
1980 & newer non-electrically heated single detached homes	1.8%	1.5%	1.3%	1.1%
1980 & newer electrically heated single detached homes	8.2%	6.3%	5.0%	4.1%
Total SDH	1.5%	1.4%	1.3%	1.2%
1980 & newer non-electrically heated attached/row housing	1.9%	1.6%	1.4%	1.1%
1980 & newer electrically heated attached/row housing	13.1%	9.6%	7.6%	6.2%
Total Attached	2.0%	2.1%	2.1%	2.0%
Non-electrically heated apartment units	1.8%	1.6%	1.4%	1.2%
Non-electrically heated apartment common areas	1.7%	1.5%	1.3%	1.2%
Electrically heated apartment units	13.2%	11.7%	10.2%	8.9%
Electrically heated apartment common areas	13.0%	11.5%	10.0%	8.7%
Total Apartment	3.6%	4.0%	4.3%	4.5%
Non-electrically heated mobile/other	1.0%	0.9%	0.8%	0.7%
Electrically heated mobile/other	4.8%	4.2%	3.7%	3.2%
Total Mobile	1.5%	1.4%	1.3%	1.2%
Small diesel grid housing	0.6%	0.6%	0.6%	0.7%
Seasonal housing	1.0%	0.9%	0.8%	0.7%
Residential garages	1.0%	0.9%	0.8%	0.7%
Sentinel Lighting	0.9%	0.8%	0.7%	0.6%
Grand Total	1.6%	1.6%	1.6%	1.6%

The growth rates of different dwelling types differ because they are present in different proportions in the different supply systems. Exhibit C 10 provides growth rates by supply system.

Exhibit C 10 Residential Stock Growth Rates by Supply System, 2010 to 2030

Supply System	Annualized Stock Growth Rates by Period			
	2010-2015	2015-2020	2020-2025	2025-2030
Hydro Grid	1.7%	1.7%	1.7%	1.7%
Large Diesel	0.2%	0.2%	0.2%	0.2%
Small Diesel	0.0%	0.0%	0.0%	0.0%
Old Crow	1.4%	1.4%	1.4%	1.4%
Grand Total	1.6%	1.6%	1.6%	1.6%

C.6 Results by Supply System

This section of the appendix presents the base year electricity consumption for the hydro grid, large diesel, small diesel and Old Crow supply systems. For each supply system, a version of Exhibit 18 is provided below. The underlying assumptions such as unit energy consumption, saturation and electricity share are not presented by supply system. This section also does not replicate the pie charts and other graphs presented in Section 5. If those graphs are needed for each supply system, they can be created using the Data Manager.

Exhibit C 11 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Hydro Grid Accounts (MWh/yr.)

Dwelling Types	Milestone Years	HVAC	Appliances	Electronics	DHW	Other	Lighting	TOTAL
Single Detached House	2010	23,697	22,067	11,820	19,591	13,330	9,273	99,778
	2015	27,153	22,580	14,877	19,617	12,597	9,330	106,154
	2020	30,901	23,778	18,601	19,665	12,299	9,285	114,529
	2025	34,807	25,266	22,821	20,164	15,449	9,120	127,627
	2030	38,773	26,931	28,792	20,627	22,089	8,833	146,045
Apartment/Condo Suites and Common Areas	2010	3,588	2,888	2,038	1,899	1,091	2,032	13,536
	2015	5,138	2,597	2,821	2,100	1,328	2,214	16,198
	2020	7,493	3,025	3,965	2,425	1,765	2,434	21,106
	2025	10,856	3,659	5,547	2,949	2,747	2,678	28,436
	2030	15,393	4,511	8,034	3,653	4,718	2,918	39,227
Attached Dwelling	2010	1,971	2,027	1,446	2,049	1,615	824	9,932
	2015	2,399	2,138	1,855	2,108	1,530	840	10,869
	2020	2,929	2,295	2,369	2,195	1,471	851	12,110
	2025	3,552	2,535	2,963	2,355	1,826	852	14,084
	2030	4,257	2,802	3,795	2,537	2,602	840	16,833
Mobile	2010	2,280	1,798	1,239	2,092	886	841	9,137
	2015	2,620	1,782	1,553	2,095	897	847	9,793
	2020	2,968	1,863	1,930	2,100	965	844	10,670
	2025	3,318	1,969	2,347	2,153	1,279	830	11,896
	2030	3,666	2,090	2,928	2,203	1,886	805	13,579
Garages and Seasonal Housing	2010	383	690	383	744	1,345	895	4,440
	2015	402	689	482	725	1,282	879	4,459
	2020	420	704	620	703	1,257	855	4,559
	2025	436	725	802	697	1,503	821	4,985
	2030	451	750	1,087	688	1,991	779	5,747
Sentinel Lighting	2010	-	-	-	-	-	515	515
	2015	-	-	-	-	-	530	530
	2020	-	-	-	-	-	543	543
	2025	-	-	-	-	-	565	565
	2030	-	-	-	-	-	585	585
TOTAL	2010	31,919	29,470	16,926	26,375	18,268	14,379	137,337
	2015	37,713	29,786	21,587	26,645	17,633	14,641	148,004
	2020	44,712	31,665	27,484	27,088	17,756	14,811	163,517
	2025	52,970	34,155	34,480	28,318	22,804	14,867	187,594
	2030	62,540	37,083	44,636	29,708	33,286	14,762	222,016

Exhibit C 12 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Large Diesel Accounts (MWh/yr.)

Dwelling Types	Milestone Years	Appliances	Electronics	DHW	HVAC	Other	Lighting	TOTAL
Single Detached House	2010	1,127	608	961	782	677	471	4,625
	2015	1,077	713	903	788	596	442	4,519
	2020	1,065	835	846	795	546	413	4,500
	2025	1,064	967	811	802	647	383	4,675
	2030	1,072	1,158	777	809	879	352	5,047
Mobile	2010	163	113	184	155	80	77	771
	2015	151	132	173	156	76	72	760
	2020	149	154	162	158	76	67	766
	2025	148	177	155	159	96	62	796
	2030	148	209	149	160	134	58	857
Attached Dwelling	2010	104	74	100	69	82	42	471
	2015	100	87	95	70	71	39	462
	2020	98	101	89	71	62	36	458
	2025	99	116	86	72	70	33	476
	2030	99	136	83	73	92	30	512
Apartment/Condo Suites and Common Areas	2010	43	24	46	21	76	52	261
	2015	41	29	43	21	70	49	253
	2020	41	35	41	21	67	46	251
	2025	40	45	39	21	81	43	269
	2030	41	59	37	22	108	39	306
Garages and Seasonal Housing	2010	63	49	44	46	15	34	250
	2015	50	58	42	47	17	32	246
	2020	49	68	40	49	21	30	257
	2025	48	79	39	50	30	27	274
	2030	48	95	38	51	46	25	304
Sentinel Lighting	2010	-	-	-	-	-	55	55
	2015	-	-	-	-	-	54	54
	2020	-	-	-	-	-	53	53
	2025	-	-	-	-	-	54	54
	2030	-	-	-	-	-	54	54
TOTAL	2010	1,500	867	1,335	1,072	930	730	6,434
	2015	1,419	1,018	1,256	1,083	829	688	6,294
	2020	1,401	1,194	1,177	1,094	773	645	6,284
	2025	1,400	1,383	1,130	1,104	924	602	6,543
	2030	1,408	1,656	1,084	1,115	1,260	558	7,081

Exhibit C 13 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Small Diesel Accounts (MWh/yr.)

Dwelling Types	Milestone Years	Appliances	DHW	Electronics	Other	Lighting	HVAC	TOTAL
Small Grid Housing	2010	285	282	149	170	133	115	1,133
	2015	275	263	174	147	123	115	1,098
	2020	269	244	204	130	114	115	1,076
	2025	266	232	236	146	105	115	1,099
	2030	265	219	283	183	95	115	1,161
Garages and Seasonal Housing	2010	12	13	7	19	13	3	67
	2015	12	12	8	17	12	3	64
	2020	11	11	10	15	12	3	62
	2025	11	11	12	18	11	3	66
	2030	11	10	16	23	10	3	74
Sentinel Lighting	2010	-	-	-	-	38	-	38
	2015	-	-	-	-	38	-	38
	2020	-	-	-	-	37	-	37
	2025	-	-	-	-	37	-	37
	2030	-	-	-	-	37	-	37
TOTAL	2010	297	295	156	189	184	118	1,239
	2015	287	275	182	164	173	118	1,199
	2020	281	255	213	146	162	118	1,175
	2025	277	242	248	164	152	118	1,201
	2030	276	230	299	206	142	118	1,271

Exhibit C 14 Reference Case Electricity Consumption, Modelled by End Use, Dwelling Type and Milestone Year, Old Crow Accounts (MWh/yr.)

Dwelling Types	Milestone Years	Appliances	DHW	Electronics	Other	Lighting	HVAC	TOTAL
Small Grid Housing	2010	225	223	118	134	105	91	895
	2015	232	220	148	127	105	98	929
	2020	243	219	185	125	104	106	982
	2025	259	224	230	160	102	114	1,089
	2030	278	230	296	233	100	123	1,260
Garages and Seasonal Housing	2010	15	16	8	21	15	2	77
	2015	15	16	11	19	15	2	78
	2020	16	16	14	17	15	2	80
	2025	17	16	19	21	15	2	91
	2030	18	17	27	32	15	2	110
Sentinel Lighting	2010	-	-	-	-	1	-	1
	2015	-	-	-	-	1	-	1
	2020	-	-	-	-	1	-	1
	2025	-	-	-	-	1	-	1
	2030	-	-	-	-	1	-	1
TOTAL	2010	240	239	126	155	121	92	973
	2015	248	236	158	145	121	100	1,008
	2020	259	235	199	142	120	107	1,063
	2025	276	240	249	181	118	116	1,180
	2030	296	246	323	265	116	125	1,371

Appendix D Background-Section 6: Reference Case Peak Load

Introduction

The following exhibits show the Reference Case peak load profiles for each supply system.

Exhibit D 1 Electric Peak Loads, by Milestone Year, Peak Period and Dwelling Type, Hydro Grid Accounts (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	2010	23.8	22.2	16.6
	2015	25.4	23.9	17.6
	2020	27.4	25.9	18.9
	2025	30.2	28.6	20.9
	2030	33.7	32.0	23.4
Apartments	2010	3.4	3.2	2.0
	2015	4.1	4.0	2.4
	2020	5.4	5.3	3.2
	2025	7.3	7.2	4.4
	2030	10.0	9.9	6.1
Attached/Row Houses	2010	2.2	2.1	1.6
	2015	2.5	2.4	1.7
	2020	2.8	2.7	1.9
	2025	3.2	3.1	2.2
	2030	3.8	3.7	2.6
Mobile/Other	2010	2.2	2.0	1.6
	2015	2.4	2.2	1.7
	2020	2.6	2.4	1.8
	2025	2.9	2.7	2.0
	2030	3.2	3.0	2.3
Seasonal & Garage	2010	0.9	0.9	0.7
	2015	0.9	0.9	0.7
	2020	0.9	0.9	0.7
	2025	1.0	1.0	0.7
	2030	1.1	1.1	0.8
Sentinel Lighting	2010	0.1	0.1	0.1
	2015	0.1	0.1	0.1
	2020	0.1	0.1	0.1
	2025	0.1	0.1	0.1
	2030	0.1	0.1	0.1
Grand Total	2010	32.5	30.6	22.5
	2015	35.4	33.4	24.3
	2020	39.3	37.3	26.7
	2025	44.7	42.6	30.3
	2030	52.0	49.7	35.3

Exhibit D 2 Electric Peak Loads, by Milestone Year, Peak Period and Dwelling Type, Large Diesel Accounts (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Single Detached Houses	2010	1.05	0.98	0.73
	2015	1.02	0.95	0.71
	2020	1.01	0.94	0.69
	2025	1.02	0.96	0.71
	2030	1.07	1.01	0.74
Mobile/Other	2010	0.17	0.16	0.13
	2015	0.18	0.16	0.13
	2020	0.18	0.16	0.12
	2025	0.18	0.16	0.13
	2030	0.19	0.17	0.13
Attached/Row Houses	2010	0.10	0.10	0.07
	2015	0.10	0.09	0.07
	2020	0.10	0.09	0.07
	2025	0.10	0.10	0.07
	2030	0.11	0.10	0.07
Apartments	2010	0.06	0.05	0.04
	2015	0.05	0.05	0.04
	2020	0.05	0.05	0.04
	2025	0.06	0.05	0.04
	2030	0.06	0.06	0.04
Seasonal & Garage	2010	0.05	0.05	0.04
	2015	0.05	0.05	0.04
	2020	0.05	0.05	0.04
	2025	0.05	0.05	0.04
	2030	0.06	0.06	0.04
Sentinel Lighting	2010	0.01	0.01	0.01
	2015	0.01	0.01	0.01
	2020	0.01	0.01	0.01
	2025	0.01	0.01	0.01
	2030	0.01	0.01	0.01
Grand Total	2010	1.45	1.35	1.02
	2015	1.42	1.32	0.99
	2020	1.40	1.31	0.97
	2025	1.43	1.34	0.99
	2030	1.49	1.41	1.04

Exhibit D 3 Electric Peak Loads, by Milestone Year, Peak Period and Dwelling Type, Small Diesel Accounts (MW)

Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Small Grid Houses	2010	0.25	0.23	0.18
	2015	0.24	0.22	0.17
	2020	0.23	0.21	0.16
	2025	0.23	0.21	0.16
	2030	0.24	0.22	0.17
Seasonal & Garage	2010	0.01	0.01	0.01
	2015	0.01	0.01	0.01
	2020	0.01	0.01	0.01
	2025	0.01	0.01	0.01
	2030	0.01	0.01	0.01
Sentinel Lighting	2010	0.01	0.01	0.01
	2015	0.01	0.01	0.01
	2020	0.01	0.01	0.01
	2025	0.01	0.01	0.01
	2030	0.01	0.01	0.01
Grand Total	2010	0.27	0.25	0.20
	2015	0.26	0.24	0.19
	2020	0.25	0.23	0.18
	2025	0.25	0.23	0.18
	2030	0.26	0.24	0.19

Exhibit D 4 Electric Peak Loads, by Milestone Year, Peak Period and Dwelling Type, Old Crow Accounts (MW)

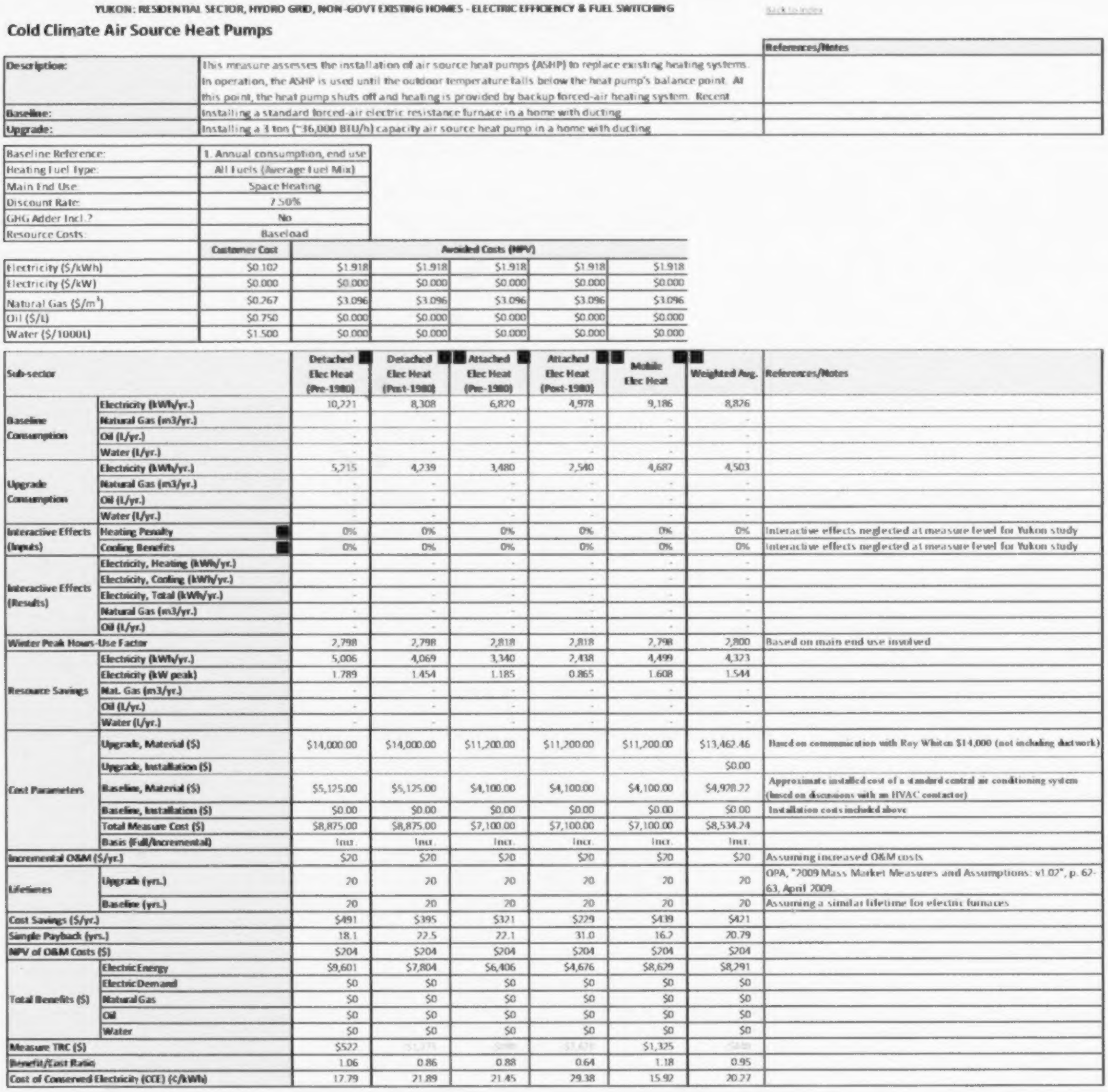
Dwelling Type	Milestone Year	Period 1 Annual Peak Hour	Period 2 Evening Peak Period	Period 3 Morning Peak Period
Small Grid Houses	2010	0.20	0.18	0.14
	2015	0.20	0.19	0.14
	2020	0.21	0.19	0.15
	2025	0.23	0.21	0.16
	2030	0.25	0.24	0.18
Seasonal & Garage	2010	0.01	0.01	0.01
	2015	0.01	0.01	0.01
	2020	0.02	0.01	0.01
	2025	0.02	0.02	0.01
	2030	0.02	0.02	0.02
Sentinel Lighting	2010	0.00	0.00	0.00
	2015	0.00	0.00	0.00
	2020	0.00	0.00	0.00
	2025	0.00	0.00	0.00
	2030	0.00	0.00	0.00
Grand Total	2010	0.21	0.19	0.15
	2015	0.22	0.20	0.16
	2020	0.23	0.21	0.16
	2025	0.24	0.23	0.17
	2030	0.27	0.26	0.20

Appendix E Background-Section 7: Technology Assessment: Energy-efficiency Measures

Introduction

Exhibit E 1 provides an example of part of the worksheet that calculates the CCE for programmable thermostats, one of the analyzed measures. For more detail on this and all the other measures, refer to the measure TRC model Excel workbooks submitted with this deliverable.

Exhibit E 1 Sample Measure CCE Calculation Worksheet



YUKON: RESIDENTIAL SECTOR, HYDRO GRID, NON-GOVT EXISTING HOMES - ELECTRIC EFFICIENCY & FUEL SWITCHING

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Cold Climate Air Source Heat Pumps

		References/Notes
Description:	This measure assesses the installation of air source heat pumps (ASHP) to replace existing heating systems. In operation, the ASHP is used until the outdoor temperature falls below the heat pump's balance point. At this point, the heat pump shuts off and heating is provided by backup forced-air heating system. Recent	
Baseline:	Installing a standard forced-air electric resistance furnace in a home with ducting	
Upgrade:	Installing a 3 ton (~36,000 BTU/h) capacity air source heat pump in a home with ducting	

Baseline Reference:	1. Annual consumption, end use
Heating Fuel Type:	All Fuels (Average Fuel Mix)
Main End Use:	Space Heating
Discount Rate:	7.50%
GHG Adder Incl.?	No
Resource Costs:	Baseload

	Customer Cost	Avoided Costs (NPV)				
Electricity ($/kWh)	$0.102	$1.918	$1.918	$1.918	$1.918	$1.918
Electricity ($/kW)	$0.000	$0.000	$0.000	$0.000	$0.000	$0.000
Natural Gas ($/m^3)	$0.267	$3.096	$3.096	$3.096	$3.096	$3.096
Oil ($/L)	$0.750	$0.000	$0.000	$0.000	$0.000	$0.000
Water ($/1000L)	$1.500	$0.000	$0.000	$0.000	$0.000	$0.000

Sub-sector		Detached Elec Heat (Pre-1980)	Detached Elec Heat (Post-1980)	Attached Elec Heat (Pre-1980)	Attached Elec Heat (Post-1980)	Mobile Elec Heat	Weighted Avg.	References/Notes
Baseline Consumption	**Electricity (kWh/yr.)**	10,221	8,308	6,820	4,978	9,186	8,826	
	Natural Gas (m3/yr.)	-	-	-	-	-	-	
	Oil (L/yr.)	-	-	-	-	-	-	
	Water (L/yr.)	-	-	-	-	-	-	
Upgrade Consumption	**Electricity (kWh/yr.)**	5,215	4,239	3,480	2,540	4,687	4,503	
	Natural Gas (m3/yr.)	-	-	-	-	-	-	
	Oil (L/yr.)	-	-	-	-	-	-	
	Water (L/yr.)	-	-	-	-	-	-	
Interactive Effects (Inputs)	**Heating Penalty**	0%	0%	0%	0%	0%	0%	Interactive effects neglected at measure level for Yukon study
	Cooling Benefits	0%	0%	0%	0%	0%	0%	Interactive effects neglected at measure level for Yukon study
Interactive Effects (Results)	**Electricity, Heating (kWh/yr.)**	-	-	-	-	-	-	
	Electricity, Cooling (kWh/yr.)	-	-	-	-	-	-	
	Electricity, Total (kWh/yr.)	-	-	-	-	-	-	
	Natural Gas (m3/yr.)	-	-	-	-	-	-	
	Oil (L/yr.)	-	-	-	-	-	-	
Winter Peak Hours-Use Factor		2,798	2,798	2,818	2,818	2,798	2,800	Based on main end use involved
Resource Savings	**Electricity (kWh/yr.)**	5,006	4,069	3,340	2,438	4,499	4,323	
	Electricity (kW peak)	1.789	1.454	1.185	0.865	1.608	1.544	
	Nat. Gas (m3/yr.)	-	-	-	-	-	-	
	Oil (L/yr.)	-	-	-	-	-	-	
	Water (L/yr.)	-	-	-	-	-	-	
Cost Parameters	**Upgrade, Material ($)**	$14,000.00	$14,000.00	$11,200.00	$11,200.00	$11,200.00	$13,462.46	Based on communication with Roy Whiten $14,000 (not including ductwork)
	Upgrade, Installation ($)						$0.00	
	Baseline, Material ($)	$5,125.00	$5,125.00	$4,100.00	$4,100.00	$4,100.00	$4,928.22	Approximate installed cost of a standard central air conditioning system (based on discussions with an HVAC contactor)
	Baseline, Installation ($)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	Installation costs included above
	Total Measure Cost ($)	$8,875.00	$8,875.00	$7,100.00	$7,100.00	$7,100.00	$8,534.24	
	Basis (Full/Incremental)	Incr.	Incr.	Incr.	Incr.	Incr.	Incr.	
Incremental O&M ($/yr.)		$20	$20	$20	$20	$20	$20	Assuming increased O&M costs
Lifetimes	**Upgrade (yrs.)**	20	20	20	20	20	20	OPA, "2009 Mass Market Measures and Assumptions: v1.02", p. 62-63, April 2009.
	Baseline (yrs.)	20	20	20	20	20	20	Assuming a similar lifetime for electric furnaces
Cost Savings ($/yr.)		$491	$395	$321	$229	$439	$421	
Simple Payback (yrs.)		18.1	22.5	22.1	31.0	16.2	20.79	
NPV of O&M Costs ($)		$204	$204	$204	$204	$204	$204	
Total Benefits ($)	**Electric Energy**	$9,601	$7,804	$6,406	$4,676	$8,629	$8,291	
	Electric Demand	$0	$0	$0	$0	$0	$0	
	Natural Gas	$0	$0	$0	$0	$0	$0	
	Oil	$0	$0	$0	$0	$0	$0	
	Water	$0	$0	$0	$0	$0	$0	
Measure TRC ($)		$522	$1,275	[illegible]	[illegible]	$1,325	[illegible]	
Benefit/Cost Ratio		1.06	0.86	0.88	0.64	1.18	0.95	
Cost of Conserved Electricity (CCE) (¢/kWh)		17.79	21.89	21.45	29.38	15.92	20.27	

Appendix F Background-Section 8: Economic Potential: Electric Energy Forecast

Introduction

The following four exhibits provide the economic potential results for the hydro grid, large diesel, small diesel and Old Crow accounts, respectively.

Exhibit F 1 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Hydro Grid Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Space heating	Domestic hot water (DHW)	Indoor lighting	Computer and peripherals	Clothes dryer	Television	Block heaters & car warmers	Refrigerator	Spa heaters and pumps
Single Detached House	2015	10,933	4,000	3,652	1,727	2,111	778	676	281	1,042
	2020	13,094	4,497	3,423	1,980	2,380	1,145	728	602	684
	2025	15,326	5,004	3,131	2,559	2,672	1,224	779	916	585
	2030	17,665	5,434	2,727	3,238	2,835	1,362	828	1,001	574
Apartment/Condo Suites and Common Areas	2015	610	508	1,161	335	209	151	177	38	45
	2020	1,366	742	1,222	437	256	253	216	89	34
	2025	2,456	1,080	1,278	655	332	313	267	152	34
	2030	3,936	1,521	1,304	974	415	410	331	190	39
Attached Dwelling	2015	888	460	388	221	200	99	86	30	134
	2020	1,198	551	374	262	221	151	96	64	91
	2025	1,561	659	353	351	245	168	107	102	81
	2030	1,965	776	322	463	271	195	118	115	83
Mobile	2015	961	436	361	182	120	82	71	22	56
	2020	1,116	473	342	209	128	121	77	46	37
	2025	1,269	512	316	270	136	129	82	70	31
	2030	1,419	548	280	342	145	144	87	76	31
Garages and Seasonal Housing	2015	3	-	350	-	-	-	22	-	-
	2020	3	-	319	-	-	-	23	-	-
	2025	3	-	284	-	-	-	24	-	-
	2030	4	-	241	-	-	-	25	-	-
Sentinel Lighting	2015	-	-	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-	-	-
	2030	-	-	-	-	-	-	-	-	-
Totals	2015	13,395	5,404	5,912	2,465	2,640	1,111	1,033	371	1,276
	2020	16,777	6,264	5,680	2,888	2,986	1,670	1,140	801	846
	2025	20,615	7,254	5,363	3,835	3,386	1,835	1,258	1,240	731
	2030	24,990	8,280	4,874	5,017	3,665	2,111	1,390	1,382	727

Exhibit F 1 Continued: Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Hydro Grid Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Ventilation & circulation	Home entertainment electronics	Outdoor lighting	Freezer	Clothes washer	Set-top boxes	Dishwasher	Holiday lighting	Grand Total
Single Detached House	2015	922	109	363	61	127	-	24	80	26,887
	2020	773	177	263	133	121	-	51	54	30,105
	2025	600	475	148	220	122	101	60	28	33,950
	2030	382	1,152	23	323	120	215	66	6	37,951
Apartment/Condo Suites and Common Areas	2015	7	16	58	8	12	-	2	15	3,353
	2020	19	29	55	19	13	-	5	13	4,766
	2025	35	90	47	36	15	26	7	8	6,832
	2030	58	257	34	60	17	65	9	2	9,621
Attached Dwelling	2015	96	10	36	6	12	-	2	6	2,674
	2020	83	17	26	14	11	-	4	4	3,169
	2025	68	47	14	24	11	14	6	2	3,813
	2030	49	119	2	37	11	31	6	1	4,564
Mobile	2015	141	10	37	5	7	-	1	6	2,499
	2020	126	16	27	10	6	-	3	4	2,741
	2025	109	44	15	17	6	11	3	2	3,023
	2030	88	106	2	25	6	23	3	0	3,326
Garages and Seasonal Housing	2015	1	-	35	-	-	-	-	-	410
	2020	1	-	24	-	-	-	-	-	370
	2025	1	-	13	-	-	-	-	-	326
	2030	0	-	2	-	-	-	-	-	273
Sentinel Lighting	2015	-	-	108	-	-	-	-	-	-
	2020	-	-	111	-	-	-	-	-	-
	2025	-	-	115	-	-	-	-	-	-
	2030	-	-	119	-	-	-	-	-	-
Totals	2015	1,167	145	637	80	158	-	30	107	35,823
	2020	1,002	239	505	177	152	-	63	74	41,151
	2025	813	656	354	297	154	151	76	40	47,944
	2030	578	1,633	181	444	156	333	85	9	55,735

Exhibit F 2 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Large Diesel Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Domestic hot water (DHW)	Indoor lighting	Computer and peripherals	Clothes dryer	Television	Block heaters & car warmers	Ventilation & circulation	Spa heaters and pumps	Refrigerator
Single Detached House	2015	172	173	83	112	37	32	50	49	13
	2020	163	152	89	112	52	33	40	30	26
	2025	156	131	109	113	52	33	28	24	37
	2030	148	109	131	114	55	33	14	22	38
Mobile	2015	34	31	15	10	7	6	16	5	2
	2020	32	27	17	10	10	6	14	3	4
	2025	30	24	20	10	10	6	11	2	5
	2030	29	20	24	10	10	6	8	2	5
Attached Dwelling	2015	18	18	10	9	5	4	0	6	1
	2020	17	16	11	9	6	4	0	4	3
	2025	17	14	14	10	7	4	0	3	4
	2030	16	11	17	10	7	4	0	3	4
Apartment/Condo Suites and Common Areas	2015	5	17	7	2	3	2	-	0	1
	2020	6	15	8	3	4	2	-	0	1
	2025	6	13	9	4	4	2	-	0	2
	2030	6	11	11	4	5	2	-	0	2
Garages and Seasonal Housing	2015	-	19	-	-	-	1	-	-	-
	2020	-	17	-	-	-	1	-	-	-
	2025	-	15	-	-	-	1	-	-	-
	2030	-	12	-	-	-	1	-	-	-
Sentinel Lighting	2015	-	-	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-	-	-
	2030	-	-	-	-	-	-	-	-	-
Totals	2015	229	258	116	133	52	45	66	60	17
	2020	219	228	124	135	72	46	54	37	34
	2025	209	197	152	136	73	46	39	30	48
	2030	199	163	183	137	77	47	23	28	49

Exhibit F 2 Continued: Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Hydro Grid Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Home entertainment electronics	Outdoor lighting	Freezer	Clothes washer	Set-top boxes	Dishwasher	Holiday lighting		Space heating	Grand Total
Single Detached House	2015	5	2	3	7	-	1	4	-	25	719
	2020	8	2	6	6	-	2	2	-	26	697
	2025	20	1	9	5	4	2	1	-	27	700
	2030	46	1	13	5	9	2	0	-	28	711
Mobile	2015	1	0	0	1	-	0	0	-	3	125
	2020	1	0	1	1	-	0	0	-	3	122
	2025	3	0	1	0	1	0	0	-	3	122
	2030	8	0	2	0	2	0	0	-	3	124
Attached Dwelling	2015	0	0	0	1	-	0	0	-	2	72
	2020	1	0	1	0	-	0	0	-	3	71
	2025	2	0	1	0	1	0	0	-	3	73
	2030	4	0	1	0	1	0	0	-	3	76
Apartment/Condo Suites and Common Areas	2015	0	0	0	0	-	0	0	-	1	37
	2020	0	0	0	0	-	0	0	-	1	40
	2025	1	0	0	0	0	0	0	-	1	42
	2030	3	0	1	0	1	0	0	-	1	45
Garages and Seasonal Housing	2015	-	0	-	-	-	-	-	-	0	20
	2020	-	0	-	-	-	-	-	-	0	18
	2025	-	0	-	-	-	-	-	-	0	16
	2030	-	0	-	-	-	-	-	-	0	13
Sentinel Lighting	2015	-	11	-	-	-	-	-		-	11
	2020	-	11	-	-	-	-	-		-	11
	2025	-	11	-	-	-	-	-		-	11
	2030	-	11	-	-	-	-	-		-	11
Totals	2015	7	14	4	8	-	1	5	-	33	984
	2020	10	13	8	7	-	3	3	-	33	959
	2025	26	13	12	6	6	3	2	-	34	964
	2030	61	12	16	6	12	3	0	-	36	980

Exhibit F 3 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Small Diesel Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Indoor lighting	Domestic hot water (DHW)	Computer and peripherals	Clothes dryer	Television	Outdoor lighting	Block heaters & car warmers	Refrigerator	Spa heaters and pumps
Single Detached House	**2015**	**48.3**	**41.6**	**20.0**	**9.7**	**9.0**	**0.6**	**7.8**	**3.7**	**12.1**
	2020	**42.1**	**42.8**	**21.3**	**19.2**	**12.3**	**0.5**	**7.8**	**7.2**	**7.3**
	2025	**36.0**	**42.9**	**25.7**	**26.8**	**12.3**	**0.3**	**7.8**	**10.1**	**5.9**
	2030	**29.5**	**39.6**	**30.6**	**26.7**	**12.9**	**0.2**	**7.8**	**10.1**	**5.4**
Sentinel Lighting	**2015**	-	-	-	-	-	**7.7**	-	-	-
	2020	-	-	-	-	-	**7.5**	-	-	-
	2025	-	-	-	-	-	**7.5**	-	-	-
	2030	-	-	-	-	-	**7.4**	-	-	-
Garages and Seasonal Housing	**2015**	**5.0**	-	-	-	-	**0.1**	**0.1**	-	-
	2020	**4.3**	-	-	-	-	**0.0**	**0.1**	-	-
	2025	**3.7**	-	-	-	-	**0.0**	**0.1**	-	-
	2030	**3.0**	-	-	-	-	**0.0**	**0.1**	-	-
Totals	2015	53.3	41.6	20.0	9.7	9.0	8.3	7.9	3.7	12.1
	2020	46.4	42.8	21.3	19.2	12.3	8.0	7.9	7.2	7.3
	2025	39.7	42.9	25.7	26.8	12.3	7.8	7.9	10.1	5.9
	2030	32.5	39.6	30.6	26.7	12.9	7.7	7.9	10.1	5.4

Dwelling Type	Milestone Year	Ventilation & circulation	Home entertainment electronics	Freezer	Clothes washer	Set-top boxes	Dishwasher	Holiday lighting	Space heating	Grand Total
Single Detached House	**2015**	**2.7**	**1.4**	**0.8**	**0.6**	-	**0.3**	**1.1**	-	**159.6**
	2020	**5.7**	**2.2**	**1.6**	**1.0**	-	**0.6**	**0.7**	-	**172.2**
	2025	**9.1**	**5.5**	**2.5**	**1.2**	**1.0**	**0.6**	**0.3**	-	**188.0**
	2030	**6.5**	**12.4**	**3.4**	**1.1**	**2.0**	**0.6**	**0.1**	-	**189.1**
Sentinel Lighting	**2015**	-	-	-	-	-	-	-	-	**7.7**
	2020	-	-	-	-	-	-	-	-	**7.5**
	2025	-	-	-	-	-	-	-	-	**7.5**
	2030	-	-	-	-	-	-	-	-	**7.4**
Garages and Seasonal Housing	**2015**	-	-	-	-	-	-	- -	**0.1**	**5.1**
	2020	-	-	-	-	-	-	- -	**0.1**	**4.4**
	2025	-	-	-	-	-	-	- -	**0.1**	**3.8**
	2030	-	-	-	-	-	-	- -	**0.0**	**3.1**
Totals	2015	2.7	1.4	0.8	0.6	-	0.3	1.1 -	0.1	172.3
	2020	5.7	2.2	1.6	1.0	-	0.6	0.7 -	0.1	184.2
	2025	9.1	5.5	2.5	1.2	1.0	0.6	0.3 -	0.1	199.3
	2030	6.5	12.4	3.4	1.1	2.0	0.6	0.1 -	0.0	199.6

Exhibit F 4 Total Economic Potential Electricity Savings by End Use, Dwelling Type and Milestone Year, Old Crow Accounts (MWh/yr.)

Dwelling Type	Milestone Year	Domestic hot water (DHW)	Indoor lighting	Computer and peripherals	Clothes dryer	Television	Ventilation & circulation	Block heaters & car warmers	Spa heaters and pumps	Refrigerator
Single Detached House	2015	38.0	40.9	16.9	8.2	7.6	10.8	6.6	10.2	2.8
	2020	44.9	38.3	19.3	17.5	11.2	9.5	7.1	6.7	6.0
	2025	51.5	35.1	25.1	26.2	12.0	8.0	7.6	5.7	9.1
	2030	55.6	30.9	32.0	28.0	13.5	6.3	8.2	5.6	10.1
Garages and Seasonal Housing	2015	-	6.0	-	-	-	-	-	-	-
	2020	-	5.6	-	-	-	-	-	-	-
	2025	-	5.1	-	-	-	-	-	-	-
	2030	-	4.5	-	-	-	-	-	-	-
Sentinel Lighting	2015	-	-	-	-	-	-	-	-	-
	2020	-	-	-	-	-	-	-	-	-
	2025	-	-	-	-	-	-	-	-	-
	2030	-	-	-	-	-	-	-	-	-
Totals	2015	38.0	46.9	16.9	8.2	7.6	10.8	6.6	10.2	2.8
	2020	44.9	43.9	19.3	17.5	11.2	9.5	7.1	6.7	6.0
	2025	51.5	40.3	25.1	26.2	12.0	8.0	7.6	5.7	9.1
	2030	55.6	35.4	32.0	28.0	13.5	6.3	8.2	5.6	10.1

Dwelling Type	Milestone Year	Home entertainment electronics	Freezer	Clothes washer	Set-top boxes	Outdoor lighting	Dishwasher	Holiday lighting	Space heating	Grand Total
Single Detached House	2015	1.2	0.6	0.5	-	0.5	0.2	0.9	-	146.1
	2020	2.0	1.3	0.9	-	0.4	0.5	0.6	-	166.1
	2025	5.3	2.2	1.2	1.0	0.3	0.6	0.3	-	191.3
	2030	13.0	3.3	1.2	2.1	0.3	0.7	0.1	-	210.9
Garages and Seasonal Housing	2015	-	-	-	-	0.1	-	- -	0.1	6.0
	2020	-	-	-	-	0.1	-	- -	0.1	5.6
	2025	-	-	-	-	0.0	-	- -	0.1	5.1
	2030	-	-	-	-	0.0	-	- -	0.1	4.5
Sentinel Lighting	2015	-	-	-	-	0.2	-	-	-	0.2
	2020	-	-	-	-	0.2	-	-	-	0.2
	2025	-	-	-	-	0.2	-	-	-	0.2
	2030	-	-	-	-	0.2	-	-	-	0.2
Totals	2015	1.2	0.6	0.5	-	0.8	0.2	0.9 -	0.1	152.3
	2020	2.0	1.3	0.9	-	0.7	0.5	0.6 -	0.1	171.9
	2025	5.3	2.2	1.2	1.0	0.6	0.6	0.3 -	0.1	196.7
	2030	13.0	3.3	1.2	2.1	0.5	0.7	0.1 -	0.1	215.6

Appendix G Background-Section 9: Peak Load Measures

Introduction

Appendix G provides additional detailed information related to analysis of the electric peak load measures. For each of the measures considered, a description is provided, along with details on assumptions, factors included in the economic analysis, barriers and constraints, and program issues. Measure lifecycle costing worksheets for each measure are provided at the end of the appendix.

Overview

Electric peak load measures are typically implemented by utilities to avoid or defer the costs of capacity expansion. Capacity costs refer to all levels of capital-based investments, including generating stations (new and upgraded), transmission and distribution lines, along with substations, transformers and other infrastructure required to deliver power, primarily related to peak capacity driven requirements.

Supply capacity can be purchased, but infrastructure must still be available to deliver the supply to customers. DSM measures that reduce peak requirements avoid and/or defer these capital-intensive investments.

From the customer's side, adoption of electric peak reduction strategies is typically dependent on the overall benefits to them, including direct incentive payments or rate benefits. Under most current rates for residential (and small commercial) customers, customers are billed only for electric energy (kWh) regardless of when it is used, and not for "demand." Consequently, electric peak load measures that do not also reduce overall energy consumption do not provide any financial benefits to customers. However, the industry trend is towards more specific pricing, including time-of-use and even hourly pricing, or peak incentives that pass along some of the utility benefits to customers on a performance basis. These new pricing structures provide incentive for even residential customers to implement measures or to participate in utility peak load reduction programs, as long as the differential between peak and off-peak prices are sufficient to provide a noticeable bill saving potential. To date, these options have been limited by the availability and cost of suitable metering technology, both intra and remote house/facility data communications, and by energy measurement storage options that would enable remote and/or automated measurement and control of devices in the home.

Description of Electric Peak Reduction Measures

The following sub sections provide a description of each of the measures listed in Exhibit 40. The discussion is organized by major end use and is presented in the following sub sections:

- Water heating
- Block heater timers and storage
- Lighting
- Thermal energy storage for supplemental heating.

The discussion of each measure is organized as follows.

- Description
- Assumptions on applicability (dwelling type, unit types, vintage)

- Typical costs – one-time, incremental, operating costs
- Typical electric peak reductions
- Other benefits
- Useful life
- Barriers and constraints for economic and achievable implementation
- Program issues.

Water Heating

Switch-based Water Heating Unit Load Control
Assumptions used for Analysis

Applicable Dwelling Type(s)	▪ Single-family detached and attached, row houses, multi-family – all with individual dwelling unit control/circuits
Applicable Equipment Type	▪ Water heater with at least a 40-gallon tank
Vintage	▪ Existing and new
Costs	▪ $200 incremental cost in existing and new homes ▪ $125 incremental cost as a add-on to an existing control system ▪ Approximately $10/site/yr. maintenance/evaluation
Electric Peak Reduction	▪ 100% reduction in water heating end use evening peaks ▪ About 80% of non-standby water heating energy reduction during curtailment is recovered
Useful Life	▪ 10 years

Description

Switch-based water heating load control is accomplished by the installation of a remote control switch on either the water heater itself or on the circuits controlling the water heater. In older systems, this type of control has been accomplished via radio frequency (RF) control, which allows remote shut off of the water heater under specific capacity-constrained conditions during a limited number of pre-specified hours during winter peak months. In the systems that are currently offered, pager-based communications are used. An even more economic solution is to piggyback off of an already existing communications system. For example, if space heat control already exists, water heat control can be added via a hard-wired or wireless connection. This can significantly reduce the total cost of the water heat control.

Depending upon the length of the control, when the control is operated, and the size of the water heater tank, units can be shut off for the entire control period or cycled to limit their on time to a predetermined number of minutes per control cycle. Water heat control is commercially available and implemented in hundreds of thousands of sites in the U.S., thus demonstrating the viability of the technology, success of the programs, customer acceptance and utility satisfaction.

Applicability

Applicable dwelling types are any dwelling units with a water heater that has at least a 40-gallon tank. The size of the tank is important because it provides hot water during times when the control is in effect. The larger the water heater tank, the longer the control can be in place without disrupting the customer's comfort and living conditions.

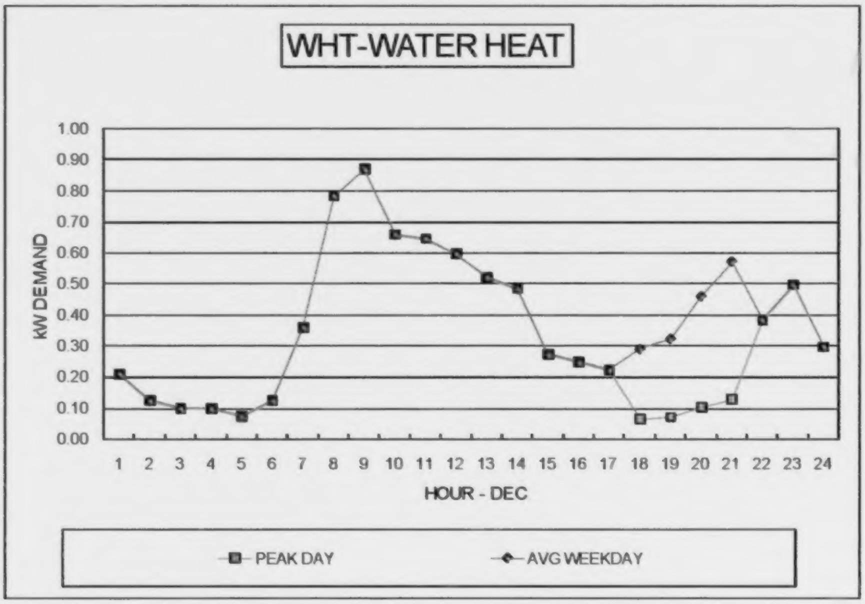
Costs

Switches cost about $100 per unit, plus $100 for installation, plus maintenance. Costs are reduced to $125 (i.e., $25 incremental installation) if the control switch can be added to an existing control system at the same time, including any remote system, which may include thermostat control, engine block heater control, lighting or other. There is no savings in installation costs for a new home.

Electric Peak Reduction

Assuming annual energy consumption per participant (with 100% electric fuel use) of 2,762 kWh, baseline electric peak period loads are estimated as 0.245 kW for the Annual Peak Hour (6 pm) and 0.273 kW for the Evening Peak (winter peak weekday 4-8 pm). Assuming 100% load control for evening peak hours, Exhibit G 1 below illustrates the baseline vs. control load profiles on the system peak day. This results in an estimated average of 0.245 kW per unit peak reduction for the Annual Peak Hour (at 6 pm) and an average of 0.273 kW per unit peak reduction for the Evening Peak (4-8 pm), assuming no overrides or switch failures. These estimates may erode over time due to a number of factors, including signal strength losses and disabling of switches (by customers and contractors). Since the water heater switch uses a one-way communications-based system, it will require support analyses including the need for signal propagation studies and periodic sampling, and re-estimation of reliability levels, accompanied by sufficient maintenance to maintain an adequate level and accurate estimate of losses. Experience in the utility industry has shown that performance could erode significantly over time if the system is not properly maintained.

Exhibit G 1 Residential Water Heater Baseline vs. Controlled Load



Other Benefits

The water heater control switch would not provide customers with any ancillary benefits and thus the only incentive for participation would be monetary in nature, likely on a per annum or per control event basis.

Useful Life

This technology has a long history, going back at least 30 years on various types of equipment, including central air conditioners, water heaters and pool pumps. For the costing analysis, a 10-year life has been assumed, although there are programs with switches in place for longer than that.

Cost-Effectiveness Summary

Based on a one-time cost of approximately $200, ongoing maintenance of 5% (about $10/yr.) and estimated annual impacts of 0.245 kW – 0.273 kW, a preliminary estimate of the CEPR is $100-$112 per kW, when applied to all potential homes, though expected to be predominantly single detached houses. As an incremental option (existing communications gateway), the installation costs would be reduced by $75 and the resulting CEPR would be $73-$81 per kW.

Barriers and Constraints

Contractors are often the cause for lack of participation or dropouts since they may incorrectly blame the switches for system performance problems, dissuading participation or resulting in removals. New tenants or their contractors may not know what the switches are and have them removed. With one-way communications, there is no way to verify whether the switch is even in place and an accurate count of actual switches in place cannot be reliably made without a systematic site verification plan.

Program Issues

Since there are no customer benefits inherent in the technology, a cash incentive would typically be expected for each season that the measure was needed, payable either by season or by event (or both). Additional work would be required to maintain, verify and evaluate the system performance to the same degree of accuracy as two-way systems due to the lack of confirmation and higher incidence of removals and failures.

Block Heater timers and storage

Engine Block Heater Load Control
Assumptions used for Analysis

Applicable Dwelling Type(s)	▪ All dwellings with individual unit control/ circuits
Applicable Equipment Type	▪ Block heaters and warmers
Vintage	▪ Existing and new
Costs	▪ $50 cost in existing and new homes (new and incremental) ▪ $25 installation cost, or $10 as an add on to an existing control system install ▪ Approximately $5/site/yr. maintenance/evaluation
Electric Peak Reduction	▪ 100% reduction in evening peaks ▪ 100% of energy reduction during curtailment is recovered
Useful Life	▪ 10 years

Description

Engine block heater timers and/or control are accomplished by the installation of a timer that could be monitored and/or controlled by the utility to ensure that it is not overridden. The critical component in this application is to defer any operation until after the 4-8 pm peak period (the Evening Peak, which includes the 6 pm Annual Peak Hour), especially in December, but including weekends as well. While timers can be used to reduce unnecessary energy consumption, reducing the heat cycle from 8-12 hours per day to the 2-3 hours per day that is required to ensure that the engines can be restored to warm enough temperatures to start, the timing of the operation is particularly key to the capacity control aspect. Ideally, operation should be staggered within local areas to prevent a local distribution peak, as well as to relieve the overall system peak associated with the 4-8 pm period for Yukon.

Applicability

Applicable dwelling types are any dwelling units with a garage or proximity of plug-in heaters to the home. This would include all but some multi-family dwellings where individual occupants do not have access to electricity for block heaters.

Costs

Switches cost about $50 per unit, plus $25 for installation, plus maintenance. Installation costs are reduced to $10 for incremental installation if the timer switch can be installed during installation of other systems. There is no savings in installation costs for a new home.

Electric Peak Reduction

Assuming annual energy consumption per participant of 258 kWh, baseline electric peak period loads are estimated as 0.173 kW for the Annual Peak Hour (6 pm) and 0.216 kW for the Evening Peak (winter peak weekday 4-8 pm). Assuming 100% load control for evening peak hours, Exhibit G 2 below illustrates the baseline vs. control load profiles on the system peak day. This results in an estimated average of 0.173 kW per unit peak reduction for the Annual Peak Hour (at 6 pm) and an average of 0.216 kW per unit peak reduction for the Evening Peak (4-8 pm), assuming no overrides or switch failures. These estimates may erode over time due to a number of factors, e.g., disabling of switches (by customers and contractors) and malfunctioning timers, so some maintenance and ongoing monitoring should be expected.

In Exhibit G 2, the red line represents the timer control option (controlled peak day) while the green line (peak day) represents the baseline. None of these load profiles assumes the use of timers used solely to reduce energy, which would not necessarily reduce evening peak demand unless specifically programmed to do so. The degree to which timers are set to defer usage and also lock out operation during 4-8 pm would be considered duplicated savings.

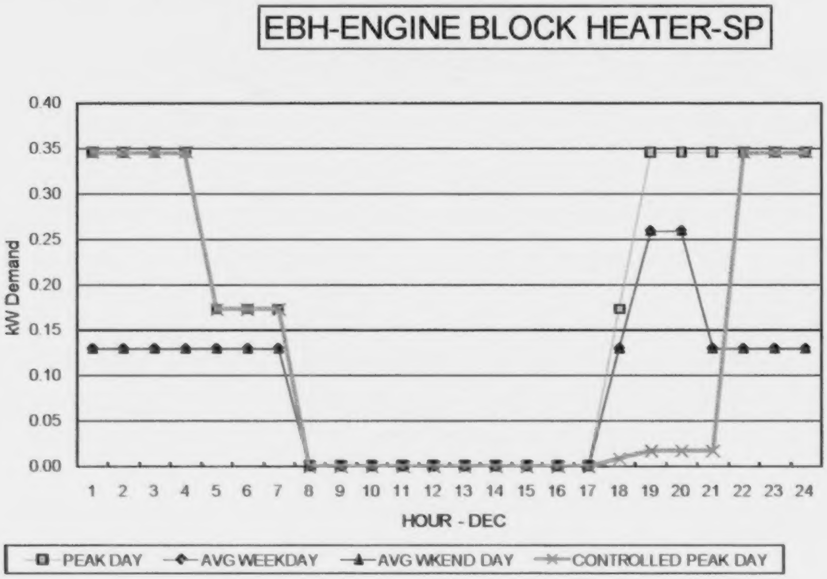
Other Benefits

The timers would also provide energy savings and, depending on any time-of-use rate in effect, could also be operated to maximize bill savings.

Useful Life

Timers are an established technology. For the costing analysis, a 10-year life has been assumed, although timers can be expected to last longer than that if maintained in clean working condition.

Exhibit G 2 Residential Block Heater Baseline vs. Controlled Load



Cost-Effectiveness Summary

Based on a one-time cost of approximately $50, ongoing maintenance of 10% (about $5/yr.) and estimated annual impacts of 0.173 kW – 0.216 kW per switch, a preliminary estimate of the CEPR is $52-$65 per kW when applied to most target sub sector homes. As an incremental option to other installations of switches, the installation costs could be reduced by $15 and the resulting CEPR would be $45-$56 per kW.

Barriers and Constraints

Contractors or residents may disconnect the timers if their schedules are disrupted, such as in power outages, depending on the nature of the switches. Some switches may not maintain the correct time without some type of battery backup. New tenants or their contractors may not know what the switches are and have them removed.

Program Issues

Without time-of-use rates, customers have no particular incentive to maintain the lock out feature or timer operation to exclude the 4-8 pm period, so some monitoring may be necessary to ensure that block heater operation avoids system peaks. Additional monitoring and sampling would be required to maintain, verify and evaluate the system performance to a sufficient degree of accuracy due to the lack of confirmation and higher incidence of removals and failures unless the system is part of an integrated home control system.

Lighting Load Control

Switch-based Lighting Load Control
Assumptions used for Analysis

Applicable Dwelling Type(s)	▪ All dwelling types
Applicable Equipment Type	▪ Non-essential lighting
Vintage	▪ Existing and new
Costs	▪ \$50 incremental cost in existing and new homes ▪ Approximately \$5/site/yr. maintenance/evaluation
Electric Peak Reduction	▪ 100% of non-essential lighting, assumed as 33% of baseline lighting usage (0.249 kW for the Annual Peak Hour) = 0.082 kW. ▪ No recovery energy is assumed
Useful Life	▪ 10 years

Description

In every home, there are a number of non-essential lighting and plug loads (including "phantom" loads[56]) that could be controlled for limited periods, such as during system peak critical hours, including holiday lights (depending on when the system peak occurs). Switch-based lighting load control is accomplished by the installation of a remote control switch on non-essential lighting circuits, wall switches and plug-in lamps or decorative lighting. Existing home automation systems currently utilize plug-in modules with communication via power line carrier or short-run radio signals. These systems can also interface with PCs and through telephone interfaces so that remote control can be accomplished as well. In terms of technical capability, the improvements to these existing systems that will facilitate their use in utility electric peak load control would require some reduced cost and more standardized and reliable remote interfaces. Current home automation systems do not typically have the capability for remote programming for on-demand control use, so this capability would need to be developed. Most likely, this would be achieved as part of an add-on wireless communications control switch linked to the outside through a remote load control system already in place to maximize or even enable cost effectiveness. What is required is a "gateway" via broadband (e.g., broadband over power lines) or through the meter (these types of systems are all now being tested in the field) that would accept outside signals (such as from the utility) and convert them to short-run wireless (or wired) signals that would trigger switches placed on selected lights and appliances.

This section describes the lighting applications only, in order to determine effect on lighting load profiles. The next section addresses aspects of non-lighting loads, although lighting and non-lighting plug loads are not expected to require separate systems, but rather a single gateway that controls switches for any plug load or, for lighting, wall switch. This technology would be applicable for single-family homes and row houses, as well as for apartments, which could make effective use of total building communications through building wiring or a building wi-fi system, as is common for electrical sub metering applications today.

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[56] Phantom loads are typically defined as standby loads on appliances, set-top boxes, televisions, electronics-charging units and other devices intended to facilitate instant-on capability or charging units/transformers that use electricity even when not being actively used for their intended purpose.

Applicability

This measure is applicable to all residential dwelling types, but would likely be most applicable to single-family homes with outdoor lighting.

Costs

Gateway systems are estimated at $100-$300 per site installed, although they would be expected to serve multiple purposes. For example, a programmable communicating thermostat or electric meter already in the house for other applications could include a relay board that would relay signals from a remote host over broadband or other remote communications to individual household devices for only this purpose. Switches are assumed to cost about $5 per unit, which could control multiple lights and plug loads. There is no savings assumed for installation costs for a new home.

Electric Peak Reduction

Based on annual lighting loads per household of 1,029 kWh, the average lighting loads per household during the 6 pm Annual Peak Hour would be 0.249 kW, or for the 4-8 pm Evening Peak approximately 0.276 kW. Assuming 33% of the lighting could be reduced with two switches, this would result in a 0.082 - 0.091 kW per household electric peak load reduction, or just under 100 Watts. In Exhibit G 3, the red line represents the timer control option (controlled peak day) during the 4-8 pm period, while the green line (peak day) represents the baseline.

Other Benefits

The gateway systems and switches would provide customers with many ancillary benefits, such as remote shut off of lights and appliances for security, convenience and energy saving, although no energy savings has been assumed for this analysis.

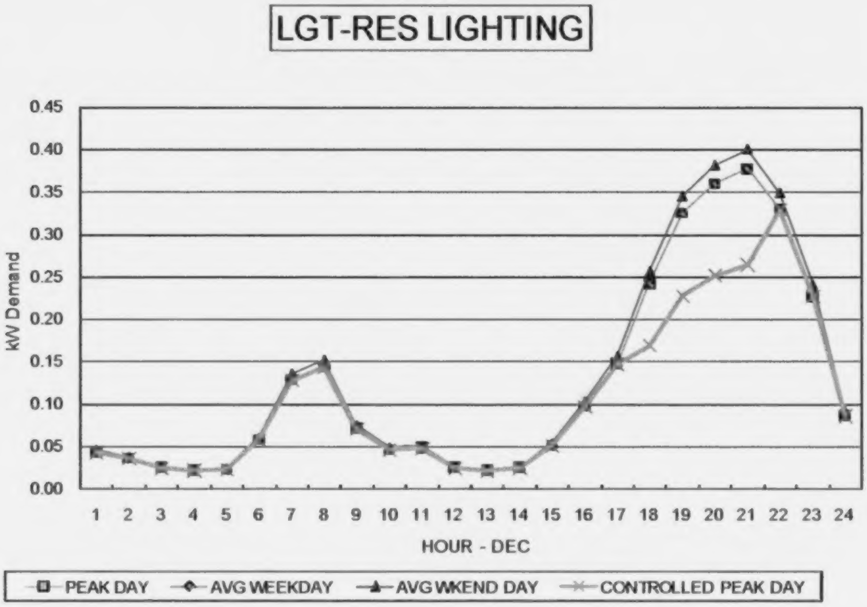
Useful Life

This technology has a fairly long history, going back at least 20 years for various protocols of home automation devices, including X-10 protocol units, which have been available through electronics stores under various brand names. For the costing analysis, a 10-year life has been assumed, although the units typically last 10-15 years.

Cost-Effectiveness Summary

There are two scenarios analyzed. Based on the inclusion of a modest ($100) gateway system installation and two switches (at $10 each), installation cost of approximately $50, ongoing maintenance/support of 10% (about $10/yr.) and estimated annual impacts of 0.082 kW – 0.091 kW, the estimated CEPR is $256-$285 per kW/yr. For practical and economic purposes, this type of system would not likely be used in stand-alone cases, so the second scenario assumes that the gateway is an existing device (e.g., meter, communicating thermostat, remote water heater control system) with no additional capital cost and only some costs ($20) for installation of switches (plug switches can be easily installed by the customer while wall switches require some experience but no electrical license), and some annual support ($5). Under this scenario, the lifecycle CEPR is $73-$81 per kW/yr.

Exhibit G 3 Residential Lighting Baseline vs. 30% Controlled Load



Barriers and Constraints

The technology for this application exists but is not quite ready for general use and would be greatly enhanced by the introduction of gateways that are only now being pilot tested. In addition, without some type of time-based rate, there would be little incentive for customers to purchase these devices, even as timers, without cash incentives.

Program Issues

In the short term, the utility could work with home electronics stores to encourage use of home automation and couple that with appeals to program the devices to shut off non-essential lighting during the defined peak period of 4-8 pm, especially holiday lighting during system critical periods. This would be facilitated by adoption of time-of-use rates that would be consistent with the peak periods, with critical peak pricing periods on a handful of system peak days providing the additional incentive for customers to utilize their systems during system peak critical periods. The switches can be overridden easily so programming them as a default to shut off certain lights for the peak winter months with the option to turn them back on if needed would be feasible.

Multiple (Whole House and Miscellaneous Plug Loads)

See the discussion on lighting (above) for description, applicability, and costs, which are the same.

Electric Peak Reduction

Based on annual plug loads and miscellaneous electronics loads per household for single-family detached houses, there are numerous devices to which this measure could be applied. Principal among these would be instant-on televisions, set-top boxes and electronic device chargers (many of which could be "ganged" on one power strip with a single switch). For the purposes of this analysis, it is assumed that 60 - 82 Watts of devices could be controlled, which represents 50% of the current peak contribution for computers, TVs, Set-top boxes, miscellaneous electronics and small appliances. The table below lists the best candidates, based on a study by LBNL,[57] as well as other sources and project team experience.

Appliance	Range of Power Consumption (Watts)
Compact Audio Components	1 – 15 W
Personal Computer	2 – 5 W
Ink Jet or Laser Printer	4 – 6 W
Large-screen television	5 – 22 W
Phone or answering machine	2 – 5 W
Set-top Box	5 – 25 W
DVD/VCR	4 – 22 W
Home Theatre[58]	12 – 56 W

Cost-Effectiveness Summary

Based on the 100% incremental scenario, whereby three switches ($15) and $5 for incremental installation costs, $2.50/year for maintenance, and estimated annual impacts of 60 to 82 Watts on demand, encompassing a mix of the above devices being controlled, the estimated CEPR is $168 - $229 per kW/yr. For practical purposes, this type of system would not be used in stand-alone cases, only as an increment to an existing gateway system with lighting switches already in place. Adding stand-alone gateway installation ($100 initial cost) would result in an estimated CEPR of $47 - $64 per kW/yr.

Swimming Pools and Spa Units

Description

Switch-based swimming pool and spa pump load control is accomplished by the installation of a remote control switch on either the pump itself or on the circuits controlling the pump. In older systems, this type of control has been accomplished via radio frequency (RF) control, which allows remote shut off of the pump under specific capacity-constrained conditions during a limited number of pre-specified hours during winter peak months. In some systems, broadband- / wi-fi-based communications can also be used. An even more economic solution is to piggyback off of an already existing communications system. For example, if space or water heat control already exists, pump control can be added via a hard-wired or wireless connection. This can reduce the total cost of the pump control by up to 50%.

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[57] Stand-by Power http:/standby.lbl.gov – Lawrence Berkeley National Labs.

[58] Standby Trends in Australia and Mandatory Standby Power Proposals, C. Edlington et al; 2006 ACEEE Summer Study on Energy Efficiency in Buildings.

Depending upon the length of the control, pumps can be shut off for the entire control period. Cycling is not recommended as it can damage the equipment. Pool and spa pump control is commercially available and implemented in hundreds of thousands of sites in the U.S., thus demonstrating the viability of the technology, success of the programs, customer acceptance and utility satisfaction.

Switch-based Swimming Pool Pump and Spa Pump Load Control
Assumptions used for Analysis

Applicable Dwelling Type(s)	▪ Single-family detached and attached, row houses, multi-family – all with individual dwelling unit control/circuits
Applicable Equipment Type	▪ Swimming pool and spa pump at least ¾ HP
Vintage	▪ Existing and new
Costs	▪ $265 incremental cost in existing and new homes ▪ $140 incremental cost as an add on to an existing control system ▪ Approximately $12/site/yr. maintenance/evaluation
Electric Peak Reduction	▪ Assume 50% of baseline loads, no energy recovery
Useful Life	▪ 10 years (comparable to lighting controls)

Applicability

Applicable dwelling types are any dwelling unit with a swimming pool or spa pumps at least ¾ HP in size. The minimum HP of the pump is necessary to ensure that enough load savings can be obtained. Swimming pools or spas that have automatic vacuum systems that run off the pump are not applicable for this control since turning off the pump while the automatic vacuum is operating can damage the vacuum.

Costs

Switches cost about $115 per unit, plus $150 for installation, plus maintenance. Costs are reduced to $125 if the control can be added to an existing control system. There is no savings in installation costs for a new home.

Electric Peak Reduction

Based on annual consumption of pools and spas of 8,164 kWh per end use for single-family detached / duplex, the predominant target for this measure, the peak period average demands are as follows:

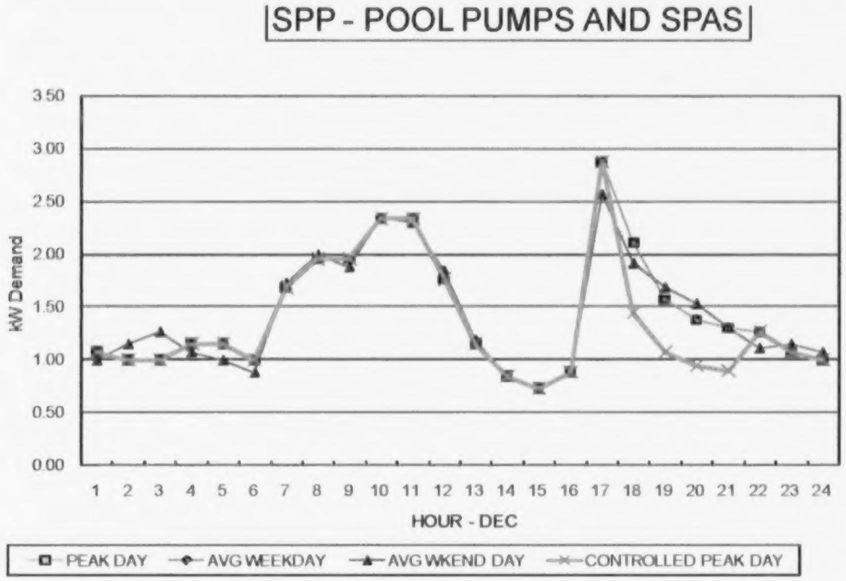
▪ Annual Peak Hour (peak day 6 pm)	1.25 kW
▪ Evening Peak (peak day 4-8 pm)	1.17 kW

Assuming 50% reduction, electric peak impacts on a household basis would thus average about 0.587 – 0.624 kW per customer for the Evening Peak, equivalent to a ¾ HP motor draw. These estimates may erode over time due to a number of factors, including signal strength losses and disabling of switches (by customers and contractors). Since the pump switch uses a one-way communications-based system, it will require support analyses including the need for signal propagation studies and periodic sampling and re-estimation of reliability levels, accompanied by sufficient maintenance, to maintain an adequate level and accurate estimate of losses.

Experience in the utility industry has shown that performance could erode significantly over time if the system is not properly maintained.

Exhibit G 4 represents the average load profile impacts, assuming a net 0.6 kW per unit reduction for pool pumps and spas. The red line represents the controlled load, as compared the peak day load in green.

Exhibit G 4 Swimming Pools and Spas Baseline vs. Controlled Load



Other Benefits

The pump control switch would not provide customers with any ancillary benefits and thus the only incentive for participation would be monetary in nature, unless time-of-use or critical peak pricing was instituted.

Useful Life

This technology has a long history, going back at least 30 years on various types of equipment, including central air conditioners, water heaters and pool pumps. For the costing analysis, a 10-year life has been assumed, comparable to lighting controls although there are programs with switches in place for longer than that.

Cost-Effectiveness Summary

Based on a one-time cost of approximately $265, ongoing maintenance of 10% (about $25/yr.) and estimated annual impacts of 0.587 – 0.624 kW, an estimate of the CEPR is $72 - $77 per kW/yr. For incremental installations, costing only $125, the CEPR is approximately $34 - $36 per kW/yr.

Barriers and Constraints

Contractors are often the cause for lack of participation or dropouts, since they may incorrectly blame the switches for system performance problems, dissuading participation or resulting in removals. New tenants or their contractors may not know what the switches are and have them removed. With one-way communications, there is no way to verify whether the switch is even in place and an accurate count of actual switches in place cannot be reliably made without a systematic site verification plan.

Program Issues

Since there are no customer benefits inherent in the technology, a cash incentive would typically be expected for each season that the measure was needed, payable either by season or by event (or both). Additional work would be required to maintain, verify and evaluate the system performance to the same degree of accuracy as two-way thermostat systems due to the lack of confirmation and higher incidence of removals and failures. The program would need to ensure that customers who shut down their units during the winter are not included, which may be problematic without having two-way communications, or some type of inexpensive logger could be used, which would add to the maintenance costs.

Electric Thermal Storage (ETS) Central Units

Description

Electric thermal storage (ETS) is a technology that has been widely used in Europe and selectively used in North America for more than 40 years. The basic premise of the systems is to convert electricity into heat and store it in specially designed high-density ceramic bricks, capable of holding heat up to 1,650°C. Combined with a utility off-peak rate, operation in charging mode during low-cost off-peak hours can provide heat all day, if properly sized, by thermostat-controlled release of heat from the bricks through either forced air or hydronic systems. Units come in various sizes, from whole-house units to individual room units. Control systems to ensure proper heat distribution are typically included and systems can be retrofitted or installed in new construction applications. The principal manufacturer in North America is Steffes Corp.,[59] and marketing is principally accomplished through electric co-ops, as well as many northern U.S. and Canadian utilities, including Nova Scotia Power and Hydro-Quebec, where a sufficient differential between peak and off-peak prices during winter months makes it economical for residents. Many winter-peaking generation/Transmission & Distribution co-ops market the units in order to minimize their capacity requirements during peak winter times.

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[59] http://www.steffes.com

Electric Thermal Storage (ETS) Central Units
Assumptions used for Analysis

Applicable Dwelling Type(s)	- Electrically heated single family, row houses and apartments – requires off-peak rate structure
Applicable Equipment Type	- Central furnace units using forced air or hydronic systems for central furnace ETS units
Vintage	- Existing and new
Costs	- Assuming 15-hour operation (9-hour overnight charge time): - $4,000-$4,500 for central ETS units vs. $1,500 for standard heating system (50,000 BTU); - Assume $500 incremental installation costs; approximately $100/site/yr. incremental maintenance
Electric Peak Reduction	- Assume 95% of current full electric loads (assuming 5% override), operating 100% off-peak otherwise, with only residual fan (same as baseline) during 15 daytime hours. Estimated 4.65 kW peak - Approximately 5% increase in space heating energy for losses
Useful Life	- 18 years (comparable to heat pump) for central

Applicability

With the various size units available, ETS can be installed in any size dwelling, either as a whole-house system or in selected (or all) rooms. It can therefore replace central furnace hot air or boiler/hydronic systems, or even baseboard systems. Often, a separate meter is used to measure just the central heating systems to best take advantage of the off-peak rate. Systems must be sized based on the time-of-use rate, with charging periods designed to virtually eliminate any operation during peak periods. For Yukon, a 15-hour peak rate period (7 am – 10 pm) and a nine-hour off-peak rate (10 pm – 7 am) would be used by the utility.

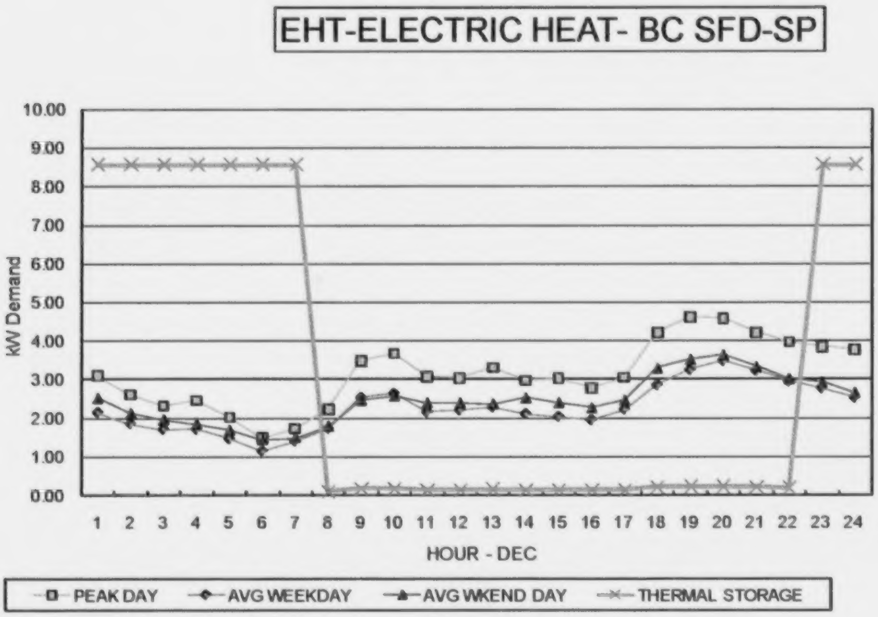
Costs

Initial costs for ETS systems are significantly higher than standard heating systems. For the economics to work for the customer, the rate differential must be significant, at least two-three to one for peak to off-peak. Initial costs are roughly proportional to the unit sizing, with an ETS system requiring two to three times the size of a standard system, and somewhat higher installation and maintenance costs. In addition, additional control equipment and sometimes wiring upgrades are necessary, as well as placement in the home (requires sufficient support for additional weight), making the specification of a system critical in terms of applicability. In general, larger homes work best. For the purpose of this study, preliminary costs have been developed based on a literature search and an interview with a representative of Steffes Corp.

Electric Peak Reduction

Electric peak load reduction would be theoretically 100% of the peak heating requirements of a standard electric space heater. Off-peak loads would be over twice the levels so it would be critical to size the systems properly for the expected charging period. For example, for a single detached house with 10,722 annual kWh for space heating, average 7 am – 10 pm loads would be about 3.5 kW, peaking at about 4.6 kW. For the costing analysis, it is assumed that 5% of the usage would still be on peak to account for minimal overrides or where units do not provide all heating requirements through off-peak charging (even though theoretically designed to do so). For a central ETS unit, the comparable overnight (charging) on a peak day would be about 8.6 kW, as illustrated in Exhibit G 5. Peak load reduction would therefore be about 4.41 kW at the hour ending 7 pm system peak and average 4.21 kW during the 4-8 pm peak period.

Exhibit G 5 Electric Thermal Storage Heating – Central Units



Other Benefits

None.

Useful Life

This technology has a long history in Europe and the bricks are virtually indestructible, so the useful life is considered the same as comparable central or room heating systems (15-18 years). Electronic control systems are required, which involve some maintenance.

Cost-Effectiveness Summary

For central systems, analysis is based on a one-time incremental cost of approximately $3,800 for the unit plus $500 installation, plus $150 for metering/control equipment and $100 annual maintenance. Estimated annual impacts of about 3.6 kW were used, based on 95% of Peak Periods 1 and 2 loads. Under those assumptions, the estimate of the CEPR is $99-$101 per kW/yr.

Barriers and Constraints

The prerequisite for an off-peak rate with significant differential is a major consideration, which would require additional metering and infrastructure (priced at $150 per site). Numerous logistical and wiring issues would also need to be addressed, which would require significantly more effort in pre-inspection and which would only be feasible for the utility's assistance if the program was large enough to warrant maintaining the staff expertise required. Space requirements and sufficient weight-bearing floors for installation of the units, which are much heavier than standard heating equipment, would be potential constraining factors to feasible installations.

Program Issues

While many co-ops and several major Canadian utilities have programs for this application, and could be consulted to assist in designing the program and identifying barriers experienced in real implementation not just pilot programs, the programming infrastructure required would involve a significant commitment. In addition, the off-peak rate would need to be in place and tested, which would require some level of regulatory approval.

Electric Thermal Storage (ETS) Room Units

Description

See the description for central units above. Room units are sized and configured to replace baseboard systems, typically as supplemental heating or for rooms not otherwise heated.

Electric Thermal Storage (ETS) Room Units
Assumptions used for Analysis

Applicable Dwelling Type(s)	▪ All dwelling types not already fully electrically heated – requires off-peak rate structure
Applicable Equipment Type	▪ Baseboard systems compatible with replacement by stand-alone room unit ETS systems
Vintage	▪ Existing and new
Costs	▪ Assuming 15-hour operation (9-hour overnight charge time): ▪ $1,200-$1,600 for room ETS units, vs. $400 for standard room baseboard system ▪ Assume $200 incremental installation costs; approximately $50/site/yr. incremental maintenance
Electric Peak Reduction	▪ Assume 95% of current full electric loads (assuming 5% override), operating 100% off-peak otherwise, with only residual fan (same as baseline) during 15 daytime hours. Estimated 35% of annual kWh attributable to target room ▪ Approximately 5% increase in space heating energy for losses
Useful Life	▪ 15 years (comparable to heat pump)

Applicability

With the various size units available, ETS can be installed in any room to replace, or supplement, electric baseboard systems. Often, a separate meter is used to measure just the central heating systems to best take advantage of the off-peak rate but a separate meter would not be viable for room units. Systems would be configured to take advantage of rates, ideally a time-of-use rate, with charging periods designed to virtually eliminate any operation during peak periods. For Yukon, a 15-hour peak rate period (7 am – 10 pm) and nine-hour off-peak rate (10 pm – 7 am) would be used by the utility.

Costs

Initial costs for ETS systems are significantly higher than standard heating systems. For the economics to work for the customer, the rate differential must be significant, at least two-three to one for peak to off-peak. Initial costs are roughly proportional to the unit sizing, with an ETS system requiring two to three times the size of a standard system, and somewhat higher installation and maintenance costs. In addition, additional control equipment and sometimes wiring upgrades are necessary, as well as placement in the home (requires sufficient support for additional weight), making the specification of a system critical in terms of applicability. In general, larger homes work best. For the purpose of this study, preliminary costs have been developed based on a literature search and an interview with a representative of Steffes Corp.

Electric Peak Reduction

Electric peak load reduction would be theoretically 100% of the peak heating requirements of a standard electric space heater for the applicable room. Off-peak loads would be over twice the levels so it would be critical to size the systems properly for the expected charging period. For example, for a large room with 3,750 annual kWh requirements for space heating, average 7 am – 10 pm loads would be about 0.85 kW, peaking at about 1.12 kW. For the costing analysis, it is assumed that 5% of the usage would still be on peak to account for minimal overrides or where units do not provide all heating requirements through off-peak charging (even though theoretically designed to do so). For a room ETS unit, the comparable overnight (charging) on a peak day would be about 2.06 kW, as illustrated in Exhibit G 6. Peak load reduction would therefore be about 1.25 kW at the hour ending 6 pm system peak.

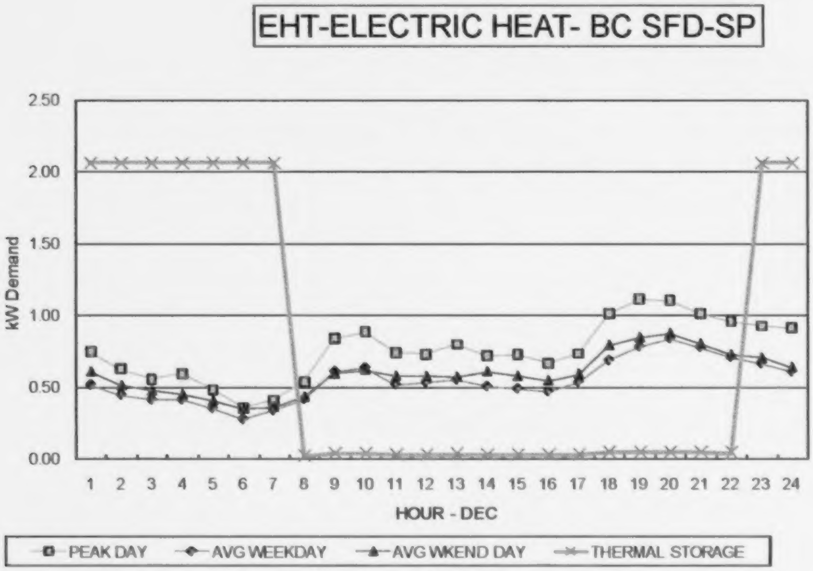
Other Benefits

None.

Useful Life

This technology has a long history in Europe and the bricks are virtually indestructible, so the useful life is considered the same as comparable room heating systems (15 years). Electronic control systems are required, which involve some maintenance.

Exhibit G 6 Electric Thermal Storage Heating – Room Unit



Cost-Effectiveness Summary

For central systems, analysis is based on a one-time incremental cost of approximately $1,000 for the unit plus $150 installation, plus $50 annual maintenance. Estimated annual impacts of 1.24–1.27 kW were used, based on 95% of Peak Periods 1 and 2 loads. Under those assumptions, a preliminary estimate of the CEPR is $85-$87 per kW/yr.

Barriers and Constraints

The existence of an off-peak rate with significant differential is a major consideration, although additional metering and infrastructure (priced at $150 per site) would not be justified solely for this purpose. Numerous logistical and wiring issues would also need to be addressed. Space requirements and sufficient weight-bearing floors for installation of the units, which are much heavier than standard heating equipment, would be potential constraining factors to feasible installations.

Program Issues

While many co-ops and several major Canadian utilities have programs for this application, which could be consulted to assist in designing the program and identifying barriers experienced in real implementation (not just pilot programs), the programming infrastructure required would involve a significant commitment.

Measure Lifecycle Costing Worksheets

The following worksheets detail the calculation of CEPR[60] for each of the electric peak measures listed.

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[60] The lifecycle measure cost is the annualized capital, installation and operating cost of the measure over its useful life.

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Water Heating

1 **One-time Costs - Retrofit**		2 **Recurring Costs ($/yr.)**		
Capital/Device	$100.00		Maintenance	$10.00
Installation	$100.00		Support	$0.00
Other	$0.00		Other	$0.00
Total	$200.00		Total	$10.00
3 **Net present Value Cost (1)**	$273.79			
	Low	High		
4 **Peak Reduction (kw/yr.)**	0.245	0.273		
5 **LIFECYCLE Peak reduction**	2.45	2.73		
			11,326	count
6 **Cost of Electric Peak Reduction (CEPR)**			2.8	MW to
(Rounded to $)	**$112.00**	**$100.00**	3.1	MW
	Average	$106.00	2.9	Avg MW
(1) Discount Rate/yr.	7.5%			
Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Water Heating (incremental)

1 **One-time Costs - Retrofit**		2 **Recurring Costs ($/yr.)**		
Capital/Device	$100.00		Maintenance	$10.00
Installation	$25.00		Support	$0.00
Other	$0.00		Other	$0.00
Total	$125.00		Total	$10.00
3 **Net present Value Cost (1)**	$198.79			
	Low	High		
4 **Peak Reduction (kw/yr.)**	0.245	0.273		
5 **LIFECYCLE Peak reduction**	2.45	2.73		
			11,326	count
6 **Cost of Electric Peak Reduction (CEPR)**			2.8	MW to
(Rounded to $)	**$81.00**	**$73.00**	3.1	MW
	Average	$77.00	2.9	Avg MW
(1) Discount Rate/yr.	7.5%			
Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

Electric Thermal Storage - Central Heating System

1	**One-time Costs**			2 **Recurring Costs ($/yr.)**		
		Capital/Device	$3,800.00		Maintenance	$100.00
		Installation	$500.00		Support	$0.00
		Other (Meter)	$150.00		Other	$0.00
		Total	$4,450.00		Total	$100.00
3	**Net present Value Cost (1)**		$5,399			
			Low	High		
4	**Peak Reduction (kw/yr.)**		3.555	3.640	(95% of Peak period 2)	
5	**LIFECYCLE Peak reduction**		53.33	54.61		
					1,916	count
6	**Cost of Electric Peak Reduction (CEPR)**				6.81	MW to
		(Rounded to $)	**$101**	**$99**	6.98	MW
			Average	$100.00	6.90	Avg MW
		(1) Discount Rate/yr.	7.5%			
		Device Lifetime (yr.s)	15			

LIFECYCLE COSTING WORKSHEET

Electric Thermal Storage - 1 Room Unit Supplemental Heating System

1	**One-time Costs**			2 **Recurring Costs ($/yr.)**		
		Capital/Device	$1,000.00		Maintenance	$50.00
		Installation	$150.00		Support	$0.00
		Other (Meter)	$0.00		Other	$0.00
		Total	$1,150.00		Total	$50.00
3	**Net present Value Cost (1)**		$1,624			
			Low	High		
4	**Peak Reduction (kw/yr.)**		1.244	1.274	(95% of Peak period 1,2)	
5	**LIFECYCLE Peak reduction**		18.67	19.11		
					1,384	count
6	**Cost of Electric Peak Reduction (CEPR)**				1.72	MW to
		(Rounded to $)	**$87**	**$85**	1.76	MW
			Average	$86.00	1.74	Avg MW
		(1) Discount Rate/yr.	7.5%			
		Device Lifetime (yr.s)	15			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Engine Block Heater

1	**One-time Costs - Retrofit**			2 **Recurring Costs ($/yr.)**		
		Capital/Device	$50.00		Maintenance	$5.00
		Installation	$25.00		Support	$0.00
		Other	$0.00		Other	$0.00
		Total	$75.00		Total	$5.00
3	**Net present Value Cost (1)**		$111.89			
			Low	High		
4	**Peak Reduction (kw/yr.)**		0.173	0.216		
5	**LIFECYCLE Peak reduction**		1.73	2.16		
					10,172	count
6	**Cost of Electric Peak Reduction (CEPR)**				1.8	MW to
		(Rounded to $)	**$65.00**	**$52.00**	2.2	MW
			Average	$58.50	2.0	Avg MW
		(1) Discount Rate/yr.	7.5%			
		Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Engine Block Heater (incremental)

1	**One-time Costs - Retrofit**			2 **Recurring Costs ($/yr.)**		
		Capital/Device	$50.00		Maintenance	$5.00
		Installation	$10.00		Support	$0.00
		Other	$0.00		Other	$0.00
		Total	$60.00		Total	$5.00
3	**Net present Value Cost (1)**		$96.89			
			Low	High		
4	**Peak Reduction (kw/yr.)**		0.173	0.216		
5	**LIFECYCLE Peak reduction**		1.73	2.16		
					10,172	count
6	**Cost of Electric Peak Reduction (CEPR)**				1.8	MW to
		(Rounded to $)	**$56.00**	**$45.00**	2.2	MW
			Average	$50.50	2.0	Avg MW
		(1) Discount Rate/yr.	7.5%			
		Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Lighting (stand-alone)

1	**One-time Costs - Retrofit**		2	**Recurring Costs ($/yr.)**	
	Capital/Device	$100.00		Maintenance	$5.00
	Installation	$50.00		Support	$5.00
	Switches	$10.00		Other	$0.00
	Total	$160.00		Total	$10.00
3	**Net present Value Cost (1)**	$233.79			
		Low	High		
4	**Peak Reduction (kw/yr.)**	0.082	0.091		
5	**LIFECYCLE Peak reduction**	0.82	0.91		
				14,622	count
6	**Cost of Electric Peak Reduction (CEPR)**			1.2	MW to
	(Rounded to $)	**$285.00**	**$256.00**	1.3	MW
		Average	$270.50	1.3	Avg MW
(1)	Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Lighting (incremental)

1	**One-time Costs - Retrofit**		2	**Recurring Costs ($/yr.)**	
	Capital/Device	$0.00		Maintenance	$0.00
	Installation	$20.00		Support	$5.00
	Switches	$10.00		Other	$0.00
	Total	$30.00		Total	$5.00
3	**Net present Value Cost (1)**	$66.89			
		Low	High		
4	**Peak Reduction (kw/yr.)**	0.082	0.091		
5	**LIFECYCLE Peak reduction**	0.82	0.91		
				14,622	count
6	**Cost of Electric Peak Reduction (CEPR)**			1.2	MW to
	(Rounded to $)	**$81.00**	**$73.00**	1.3	MW
		Average	$77.00	1.3	Avg MW
(1)	Discount Rate/yr.	7.5%			
	Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Plug Loads

1	**One-time Costs - Retrofit**			2 **Recurring Costs ($/yr.)**		
		Capital/Device	$100.00		Maintenance	$2.50
		Installation	$5.00		Support	$0.00
		Switches	$15.00		Other	$0.00
		Total	$120.00		Total	$2.50
3	**Net present Value Cost (1)**		$138.45			
			Low	High		
4	**Peak Reduction (kw/yr.)**		0.060	0.082		
5	**LIFECYCLE Peak reduction**		0.60	0.82		
					14,622	count
6	**Cost of Electric Peak Reduction (CEPR)**				0.9	MW to
		(Rounded to $)	**$229.00**	**$168.00**	1.2	MW
			Average	$198.50	1.0	Avg MW
		(1) Discount Rate/yr.	7.5%			
		Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Plug Loads (incremental)

1	**One-time Costs - Retrofit**			2 **Recurring Costs ($/yr.)**		
		Capital/Device	$0.00		Maintenance	$2.50
		Installation	$5.00		Support	$0.00
		Switches	$15.00		Other	$0.00
		Total	$20.00		Total	$2.50
3	**Net present Value Cost (1)**		$38.45			
			Low	High		
4	**Peak Reduction (kw/yr.)**		0.060	0.082		
5	**LIFECYCLE Peak reduction**		0.60	0.82		
					14,622	count
6	**Cost of Electric Peak Reduction (CEPR)**				0.9	MW to
		(Rounded to $)	**$64.00**	**$47.00**	1.2	MW
			Average	$55.50	1.0	Avg MW
		(1) Discount Rate/yr.	7.5%			
		Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Pools/Spas

1	**One-time Costs - (stand-alone)**			2	**Recurring Costs ($/yr.)**	
		Capital/Device	$115.00		Maintenance	$25.00
		Installation	$150.00		Support	$0.00
		Switches	$0.00		Other *	$0.00
		Total	$265.00		Total	$25.00
3	**Net present Value Cost (1)**		$449.47		* Rate Discount or Incentive	
			Low	High		
4	**Peak Reduction (kw/yr.)**		0.587	0.624	(50% applicable)	
5	**LIFECYCLE Peak reduction**		5.87	6.24		
					1,120	count
6	**Cost of Electric Peak Reduction (CEPR)**				0.7	MW to
		(Rounded to $)	**$77.00**	**$72.00**	0.7	MW
			Average	$74.50	0.7	Avg MW
		(1) Discount Rate/yr.	7.5%			
		Device Lifetime (yr.s)	10			

LIFECYCLE COSTING WORKSHEET

One-Way Switch - Pools/Spas

1	**One-time Costs - incremental**			2	**Recurring Costs ($/yr.)**	
		Capital/Device	$75.00		Maintenance	$12.00
		Installation	$50.00		Support	$0.00
		Switches	$0.00		Other *	$0.00
		Total	$125.00		Total	$12.00
3	**Net present Value Cost (1)**		$213.55		* Rate Discount or Incentive	
			Low	High		
4	**Peak Reduction (kw/yr.)**		0.587	0.624	(50% applicable)	
5	**LIFECYCLE Peak reduction**		5.87	6.24		
					1,120	count
6	**Cost of Electric Peak Reduction (CEPR)**				0.7	MW to
		(Rounded to $)	**$36.00**	**$34.00**	0.7	MW
			Average	$35.00	0.7	Avg MW
		(1) Discount Rate/yr.	7.5%			
		Device Lifetime (yr.s)	10			

Worksheets For Calculating Counts By End Use For Per-Unit Cost Calculations And Supply Curve Development

One-Way Switch - Water Heating

Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	
1980 & newer non-electrically heated single detached homes	4419	100%	79%	3,491	
Pre-1980 non-electrically heated single detached homes	3741	100%	79%	2,955	
1980 & newer electrically heated single detached homes	672	100%	100%	672	
Pre-1980 electrically heated single detached homes	570	100%	100%	570	
Total SDH					
1980 & newer non-electrically heated attached/row housing	586	100%	79%	463	
Pre-1980 non-electrically heated attached/row housing	495	100%	79%	391	
1980 & newer electrically heated attached/row housing	89	100%	100%	89	
Pre-1980 electrically heated attached/row housing	76	100%	100%	76	
Total Attached					
Non-electrically heated apartment units	1268	80%	100%	1,014	
Non-electrically heated apartment common areas	72	20%	0%	0	
Electrically heated apartment units	198	100%	100%	198	
Electrically heated apartment common areas	11	0%	100%	0	
Total Apartment					
Non-electrically heated mobile/other	884	100%	79%	698	
Electrically heated mobile/other	129	100%	100%	129	
Total Mobile					
Small diesel grid housing	266	100%	83%	221	
Seasonal housing	862	50%	83%	358	
Residential garages	284	0%	100%	0	
Sentinel Lighting	947	0%	0%	0	
	15,569				
	Annual kWh	2,762		11,326	72.7%

	Electric Thermal Storage - Central Heating System				Central Unit	Central Unit	Room Unit	Room Unit		
Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	Applicability	Count	Applicability	Count		
1980 & newer non-electrically heated single detached homes	4419	100%	5%	221	100%	221	100%	221	628	12,560
Pre-1980 non-electrically heated single detached homes	3741	100%	5%	187	100%	187	0%	0	879	17,580
1980 & newer electrically heated single detached homes	672	100%	89%	598	100%	598	0%	0	7401	8,316
Pre-1980 electrically heated single detached homes	570	100%	89%	507	100%	507	100%	507	9105	10,230
Total SDH									SDH avg	10,722
1980 & newer non-electrically heated attached/row housing	586	100%	5%	29	100%	29	100%	29		
Pre-1980 non-electrically heated attached/row housing	495	100%	5%	25	100%	25	100%	25		
1980 & newer electrically heated attached/row housing	89	100%	89%	79	100%	79	100%	79		
Pre-1980 electrically heated attached/row housing	76	100%	89%	68	100%	68	100%	68		
Total Attached										
Non-electrically heated apartment units	1268	100%	5%	63	0%	0	100%	63		
Non-electrically heated apartment common areas	72	100%	5%	4	100%	4	100%	4		
Electrically heated apartment units	198	100%	95%	188	100%	188	100%	188		
Electrically heated apartment common areas	11	100%	95%	10	100%	10	100%	10		
Total Apartment										
Non-electrically heated mobile/other	884	100%	5%	44	0%	0	100%	44		
Electrically heated mobile/other	129	100%	89%	115	0%	0	100%	115		
Total Mobile										
Small diesel grid housing	266	100%	2%	5	0%	0	100%	5		
Seasonal housing	862	50%	5%	22	0%	0	50%	11		
Residential garages	284	100%	5%	14	0%	0	100%	14		
Sentinel Lighting	947	0%	0%	0	0%	0	0%	0		
	15,569									
Single Family for Central	Annual kWh	10,722		2,180	14.0%	1,916	12.3%	1,384	8.9%	

One-Way Switch - Engine Block Heater

Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	
1980 & newer non-electrically heated single detached homes	4419	90%	100%	3,977	
Pre-1980 non-electrically heated single detached homes	3741	82%	100%	3,068	
1980 & newer electrically heated single detached homes	672	82%	100%	551	
Pre-1980 electrically heated single detached homes	570	75%	100%	428	
Total SDH					
1980 & newer non-electrically heated attached/row housing	586	86%	100%	504	
Pre-1980 non-electrically heated attached/row housing	495	76%	100%	376	
1980 & newer electrically heated attached/row housing	89	78%	100%	69	
Pre-1980 electrically heated attached/row housing	76	69%	100%	52	
Total Attached					
Non-electrically heated apartment units	1268	0%	100%	0	
Non-electrically heated apartment common areas	72	67%	100%	48	
Electrically heated apartment units	198	0%	100%	0	
Electrically heated apartment common areas	11	67%	100%	7	
Total Apartment					
Non-electrically heated mobile/other	884	67%	100%	592	
Electrically heated mobile/other	129	67%	100%	86	
Total Mobile					
Small diesel grid housing	266	75%	100%	200	
Seasonal housing	862	0%	100%	0	
Residential garages	284	75%	100%	213	
Sentinel Lighting	947	0%	100%	0	
	15,569				
	Annual kWh	258		10,172	65.3%

One-Way Switch - Lighting (stand-alone)

Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	
1980 & newer non-electrically heated single detached homes	4419	100%	100%	4,419	
Pre-1980 non-electrically heated single detached homes	3741	100%	100%	3,741	
1980 & newer electrically heated single detached homes	672	100%	100%	672	
Pre-1980 electrically heated single detached homes	570	100%	100%	570	
Total SDH					
1980 & newer non-electrically heated attached/row housing	586	100%	100%	586	
Pre-1980 non-electrically heated attached/row housing	495	100%	100%	495	
1980 & newer electrically heated attached/row housing	89	100%	100%	89	
Pre-1980 electrically heated attached/row housing	76	100%	100%	76	
Total Attached					
Non-electrically heated apartment units	1268	100%	100%	1,268	
Non-electrically heated apartment common areas	72	100%	100%	72	
Electrically heated apartment units	198	100%	100%	198	
Electrically heated apartment common areas	11	100%	100%	11	
Total Apartment					
Non-electrically heated mobile/other	884	100%	100%	884	
Electrically heated mobile/other	129	100%	100%	129	
Total Mobile					
Small diesel grid housing	266	100%	100%	266	
Seasonal housing	862	100%	100%	862	
Residential garages	284	100%	100%	284	
Sentinel Lighting	947	100%	0%	0	
	15,569				
	Annual kWh	1,029		14,622	93.9%

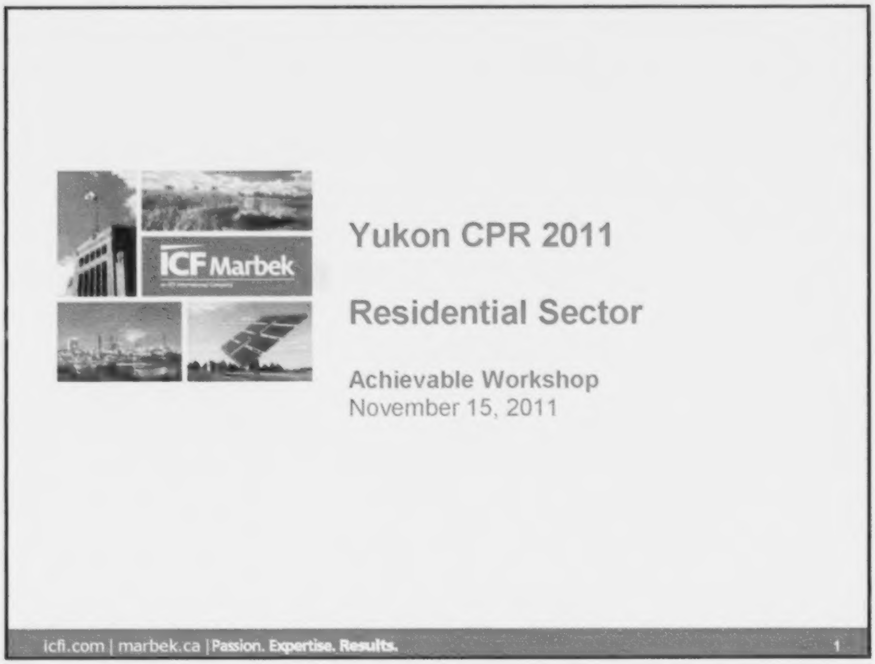
One-Way Switch - Plug Loads

Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	
1980 & newer non-electrically heated single detached homes	4419	100%	100%	4,419	
Pre-1980 non-electrically heated single detached homes	3741	100%	100%	3,741	
1980 & newer electrically heated single detached homes	672	100%	100%	672	
Pre-1980 electrically heated single detached homes	570	100%	100%	570	
Total SDH					
1980 & newer non-electrically heated attached/row housing	586	100%	100%	586	
Pre-1980 non-electrically heated attached/row housing	495	100%	100%	495	
1980 & newer electrically heated attached/row housing	89	100%	100%	89	
Pre-1980 electrically heated attached/row housing	76	100%	100%	76	
Total Attached					
Non-electrically heated apartment units	1268	100%	100%	1,268	
Non-electrically heated apartment common areas	72	100%	100%	72	
Electrically heated apartment units	198	100%	100%	198	
Electrically heated apartment common areas	11	100%	100%	11	
Total Apartment					
Non-electrically heated mobile/other	884	100%	100%	884	
Electrically heated mobile/other	129	100%	100%	129	
Total Mobile					
Small diesel grid housing	266	100%	100%	266	
Seasonal housing	862	100%	100%	862	
Residential garages	284	100%	100%	284	
Sentinel Lighting	947	100%	0%	0	
	15,569				
	Annual kWh	545		14,622	93.9%

One-Way Switch - Pools/Spas

Sector	Dwelling Units	Unit Sat	Elec Sat	Elec Units	kWh/DU	div by El Sat
1980 & newer non-electrically heated single detached homes	4419	11%	89%	433	791	888.764
Pre-1980 non-electrically heated single detached homes	3741	11%	89%	366	721	810.1124
1980 & newer electrically heated single detached homes	672	10%	100%	67	814	814
Pre-1980 electrically heated single detached homes	570	9%	100%	51	742	742
Total SDH						843.6796
1980 & newer non-electrically heated attached/row housing	586	10%	89%	52		
Pre-1980 non-electrically heated attached/row housing	495	9%	89%	40		
1980 & newer electrically heated attached/row housing	89	9%	100%	8		
Pre-1980 electrically heated attached/row housing	76	8%	100%	6		
Total Attached						
Non-electrically heated apartment units	1268	0%	100%	0		
Non-electrically heated apartment common areas	72	8%	89%	5		
Electrically heated apartment units	198	0%	100%	0		
Electrically heated apartment common areas	11	8%	100%	1		
Total Apartment						
Non-electrically heated mobile/other	884	4%	91%	32		
Electrically heated mobile/other	129	4%	100%	5		
Total Mobile						
Small diesel grid housing	266	9%	91%	22		
Seasonal housing	862	4%	91%	31		
Residential garages	284	0%	100%	0		
Sentinel Lighting	947	0%	0%	0		
	15,569					
	Annual kWh	8,164		1,120	7.2%	

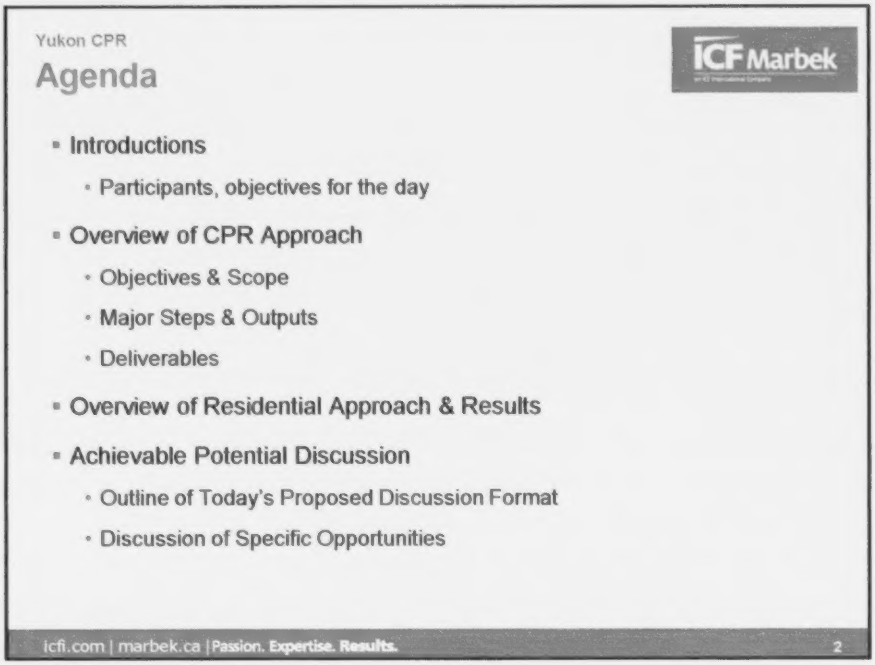
Appendix H Background-Section 10: Achievable Workshop Action Profile Slides



Yukon CPR 2011

Residential Sector

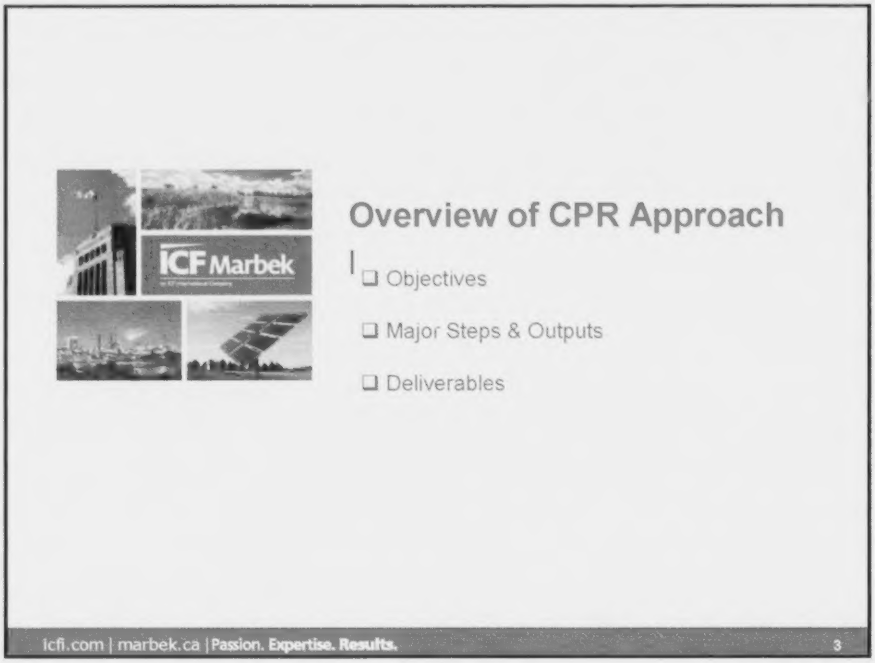
Achievable Workshop
November 15, 2011



Yukon CPR

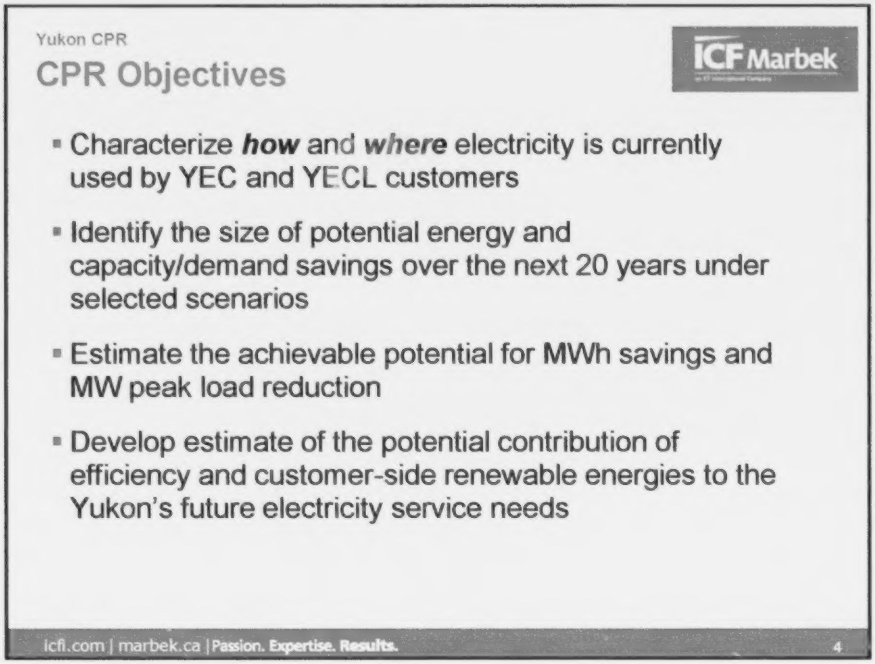
Agenda

- Introductions
  - Participants, objectives for the day
- Overview of CPR Approach
  - Objectives & Scope
  - Major Steps & Outputs
  - Deliverables
- Overview of Residential Approach & Results
- Achievable Potential Discussion
  - Outline of Today's Proposed Discussion Format
  - Discussion of Specific Opportunities



Overview of CPR Approach

- ☐ Objectives
- ☐ Major Steps & Outputs
- ☐ Deliverables



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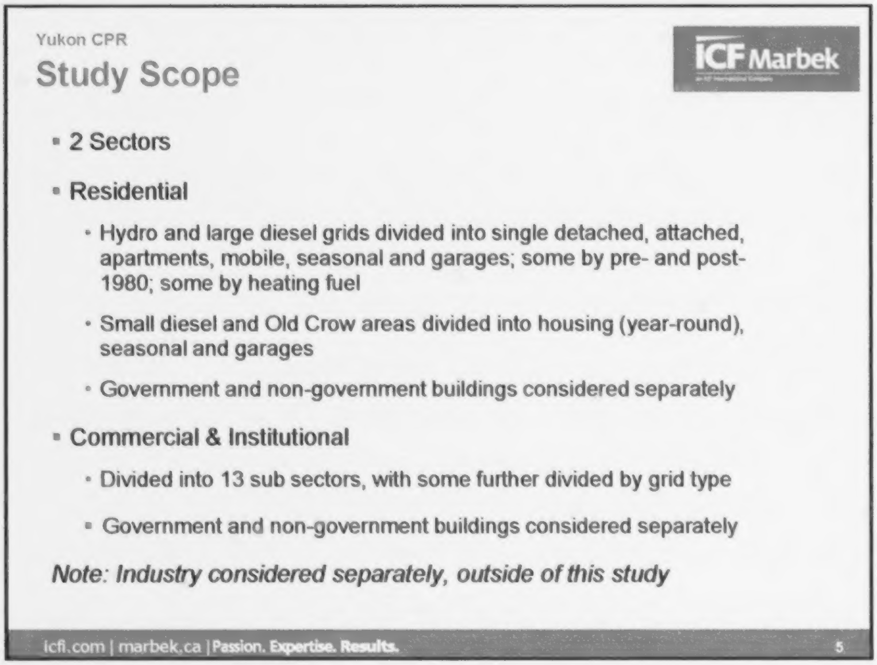
CPR Objectives

- Characterize ***how*** and ***where*** electricity is currently used by YEC and YECL customers
- Identify the size of potential energy and capacity/demand savings over the next 20 years under selected scenarios
- Estimate the achievable potential for MWh savings and MW peak load reduction
- Develop estimate of the potential contribution of efficiency and customer-side renewable energies to the Yukon's future electricity service needs



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Study Scope

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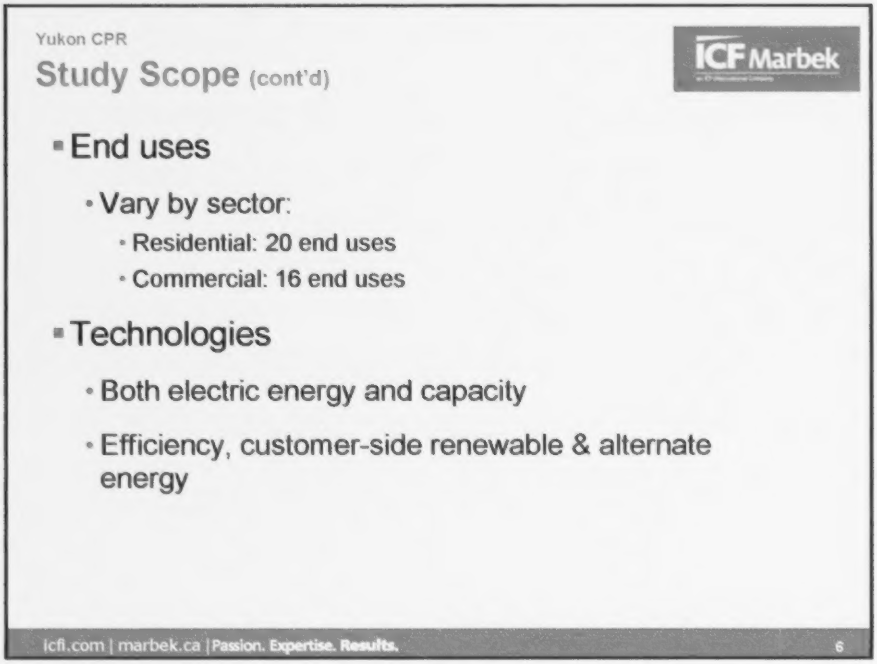
- 2 Sectors
- Residential
  - Hydro and large diesel grids divided into single detached, attached, apartments, mobile, seasonal and garages; some by pre- and post-1980; some by heating fuel
  - Small diesel and Old Crow areas divided into housing (year-round), seasonal and garages
  - Government and non-government buildings considered separately
- Commercial & Institutional
  - Divided into 13 sub sectors, with some further divided by grid type
  - Government and non-government buildings considered separately

Note: Industry considered separately, outside of this study



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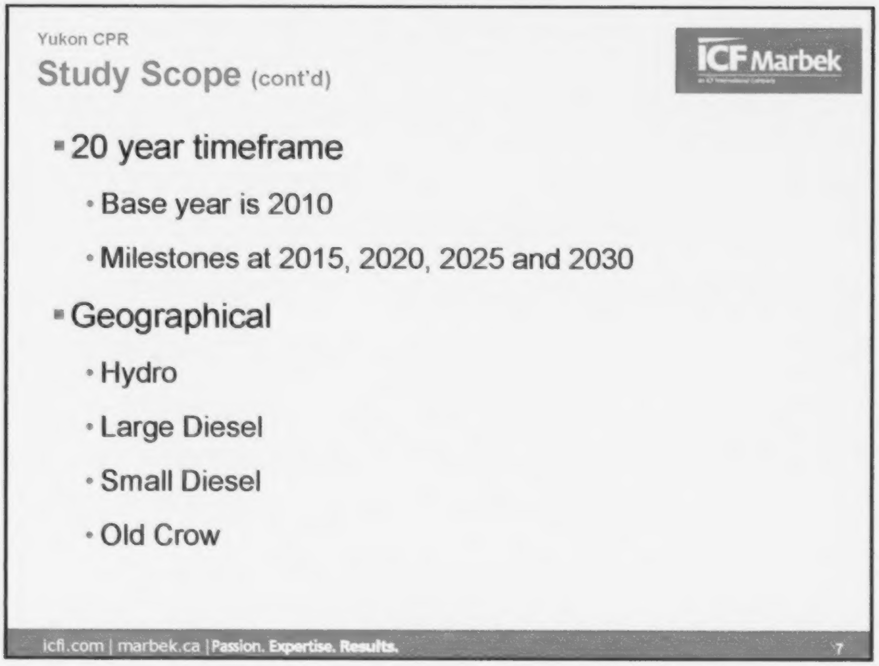
Study Scope (cont'd)

ICF Marbek

- End uses
  - Vary by sector:
    - Residential: 20 end uses
    - Commercial: 16 end uses
- Technologies
  - Both electric energy and capacity
  - Efficiency, customer-side renewable & alternate energy



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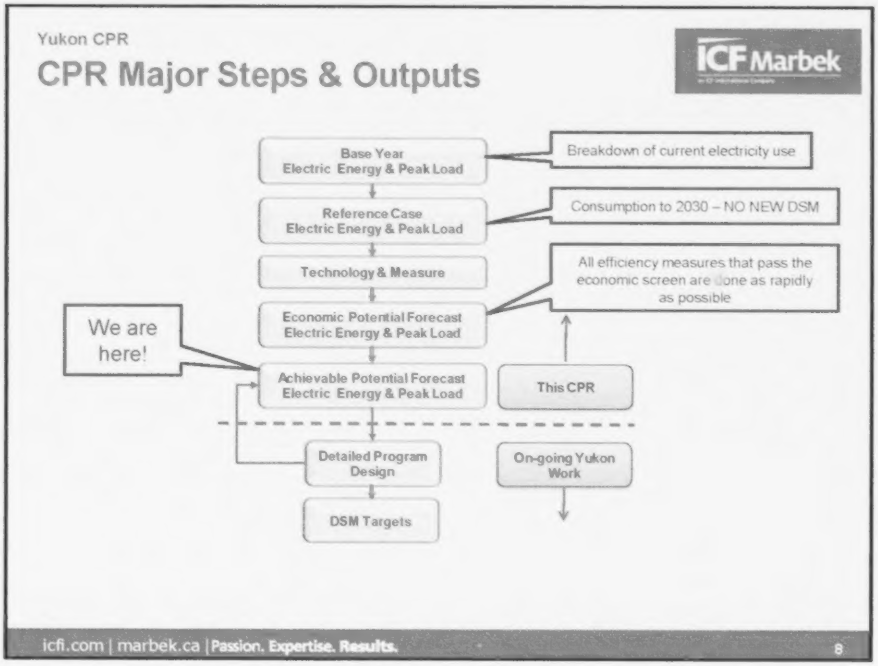
Study Scope (cont'd)

- 20 year timeframe
  - Base year is 2010
  - Milestones at 2015, 2020, 2025 and 2030
- Geographical
  - Hydro
  - Large Diesel
  - Small Diesel
  - Old Crow



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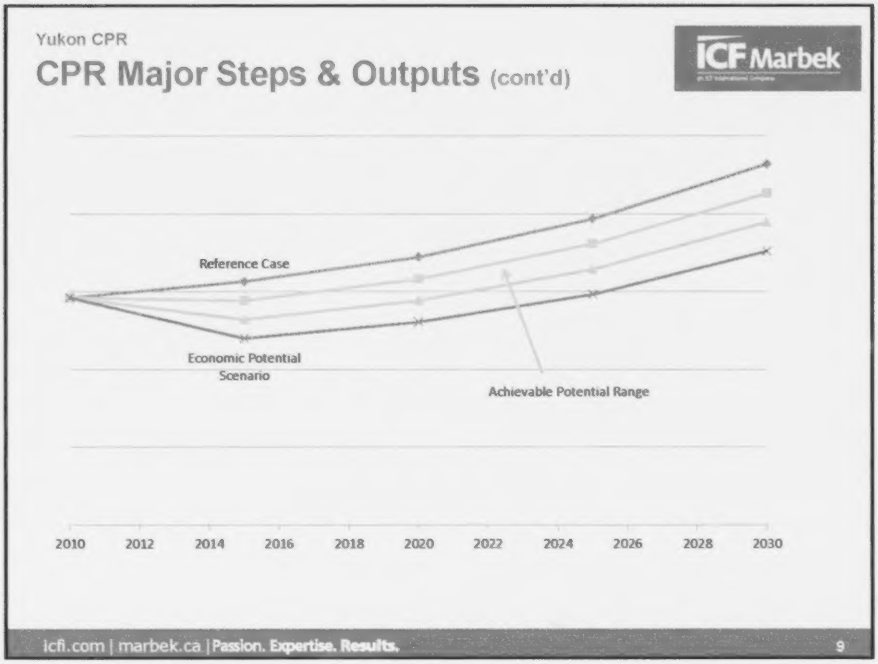
CPR Major Steps & Outputs

Base Year Electric Energy & Peak Load
Breakdown of current electricity use
Reference Case Electric Energy & Peak Load
Consumption to 2030 – NO NEW DSM
Technology & Measure
All efficiency measures that pass the economic screen are done as rapidly as possible
Economic Potential Forecast Electric Energy & Peak Load
We are here!
Achievable Potential Forecast Electric Energy & Peak Load
This CPR
Detailed Program Design
On-going Yukon Work
DSM Targets



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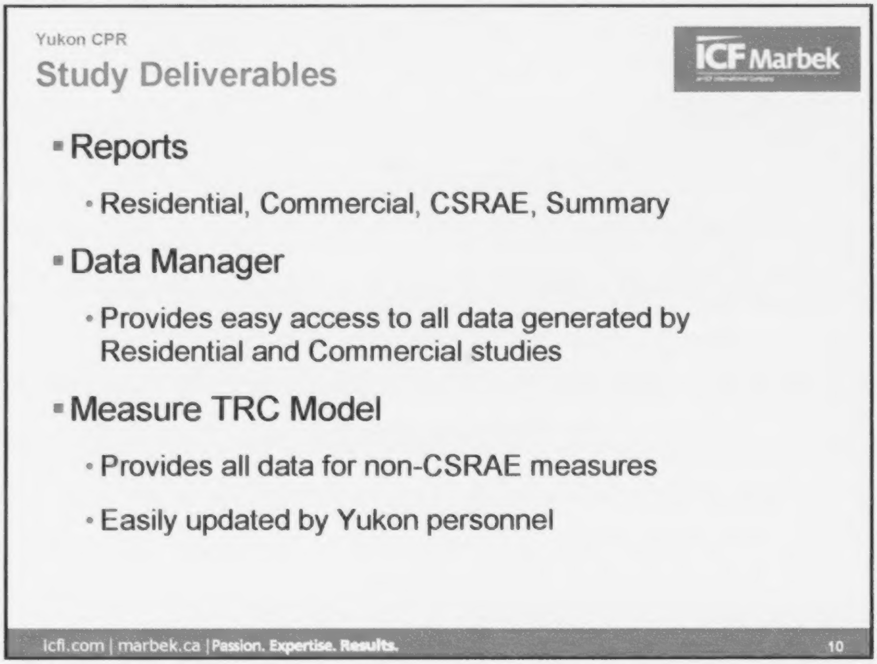
CPR Major Steps & Outputs (cont'd)



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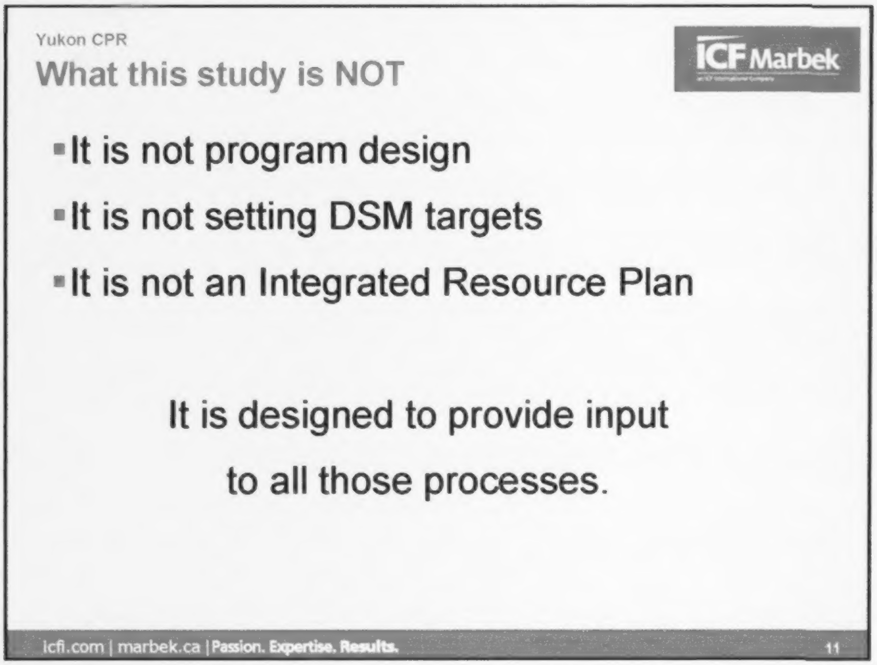
Study Deliverables

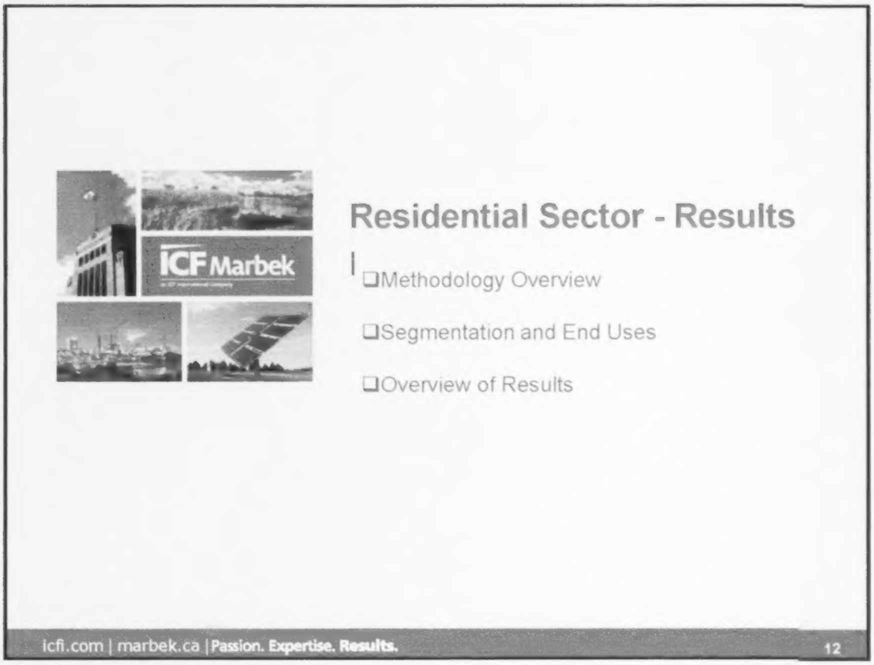
- Reports
  - Residential, Commercial, CSRAE, Summary
- Data Manager
  - Provides easy access to all data generated by Residential and Commercial studies
- Measure TRC Model
  - Provides all data for non-CSRAE measures
  - Easily updated by Yukon personnel



What this study is NOT

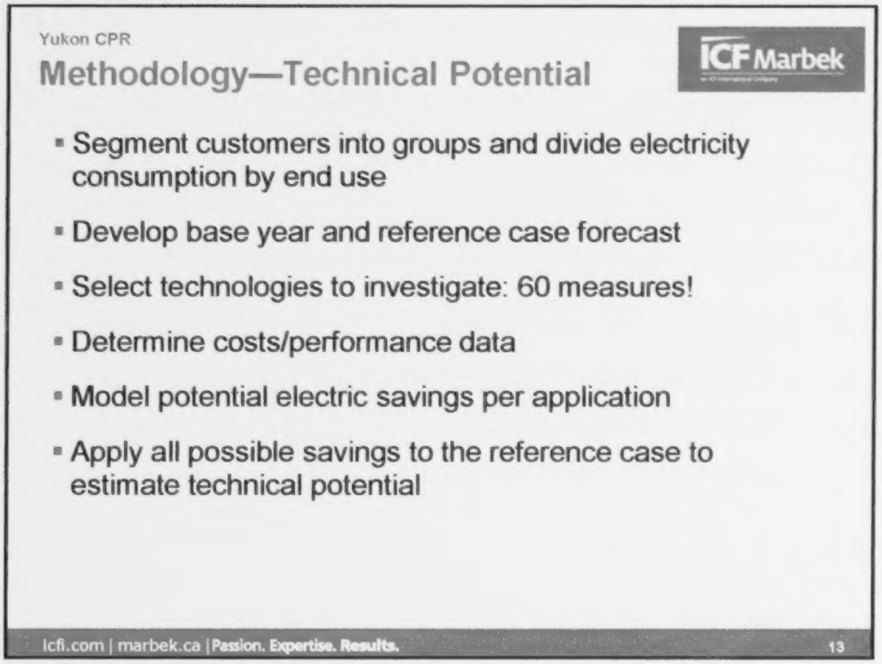
- It is not program design
- It is not setting DSM targets
- It is not an Integrated Resource Plan

It is designed to provide input
to all those processes.



Residential Sector - Results

- ☐Methodology Overview
- ☐Segmentation and End Uses
- ☐Overview of Results



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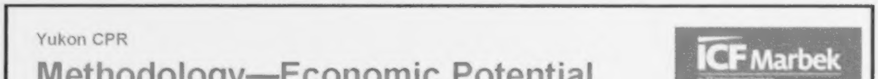
Methodology—Technical Potential

- Segment customers into groups and divide electricity consumption by end use
- Develop base year and reference case forecast
- Select technologies to investigate: 60 measures!
- Determine costs/performance data
- Model potential electric savings per application
- Apply all possible savings to the reference case to estimate technical potential

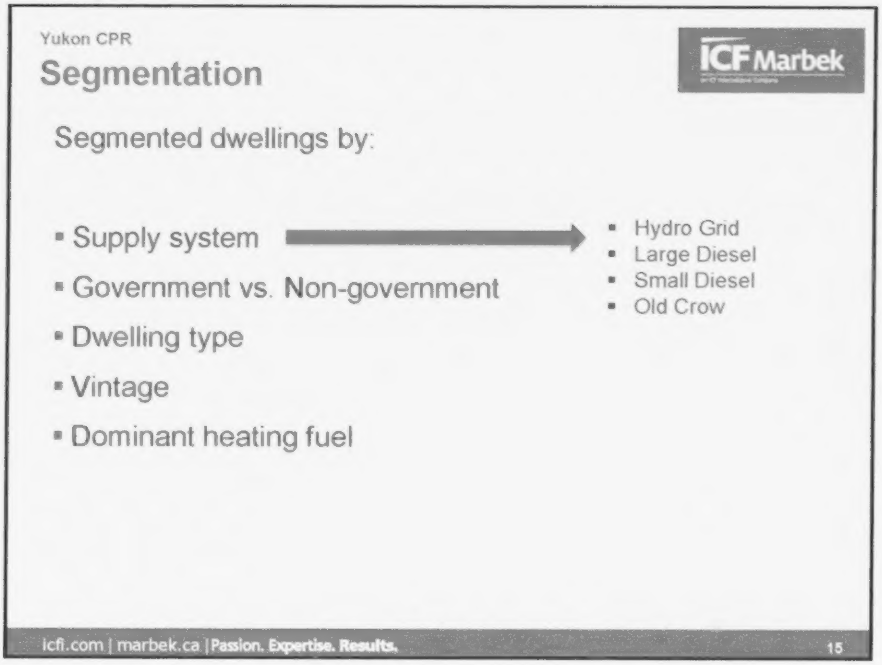


Yukon CPR

Methodology—Economic Potential

- Calculate a cost of conserved electricity (CCE) for each technology in each customer group
  - *CCE = cost of saving a kWh; can be compared with cost of generating a kWh*
- Compare against the threshold cost per kWh (based on avoided cost for the supply system)
- Apply all savings that pass this economic screen to the reference case to estimate economic potential

Then move on to the current step: Achievable Potential!



Yukon CPR

Segmentation

Segmented dwellings by:

- Supply system →
  - Hydro Grid
  - Large Diesel
  - Small Diesel
  - Old Crow
- Government vs. Non-government
- Dwelling type
- Vintage
- Dominant heating fuel

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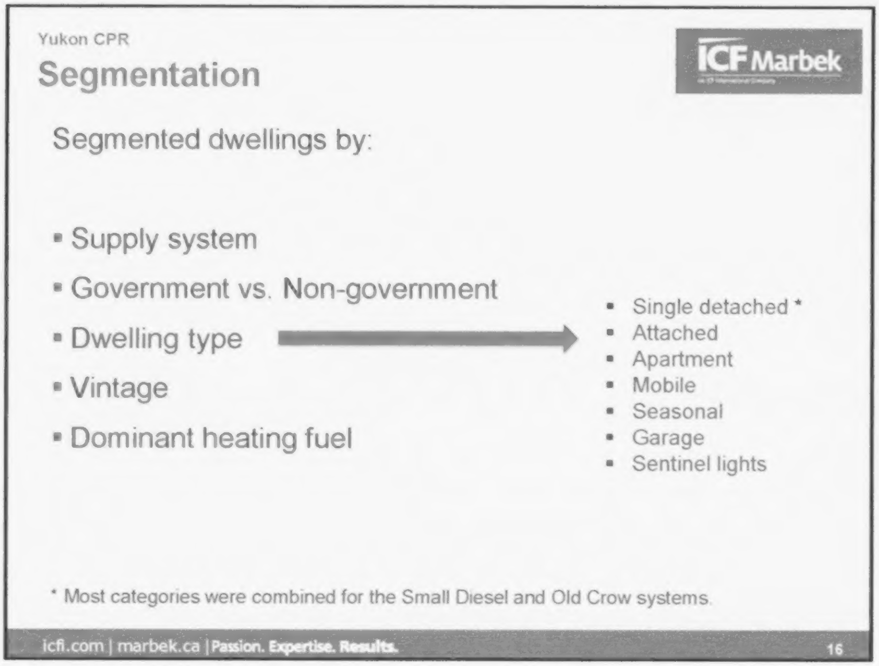

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Segmentation

Segmented dwellings by:

- Supply system
- Government vs. Non-government
- Dwelling type →
  - Single detached *
  - Attached
  - Apartment
  - Mobile
  - Seasonal
  - Garage
  - Sentinel lights
- Vintage
- Dominant heating fuel

* Most categories were combined for the Small Diesel and Old Crow systems.

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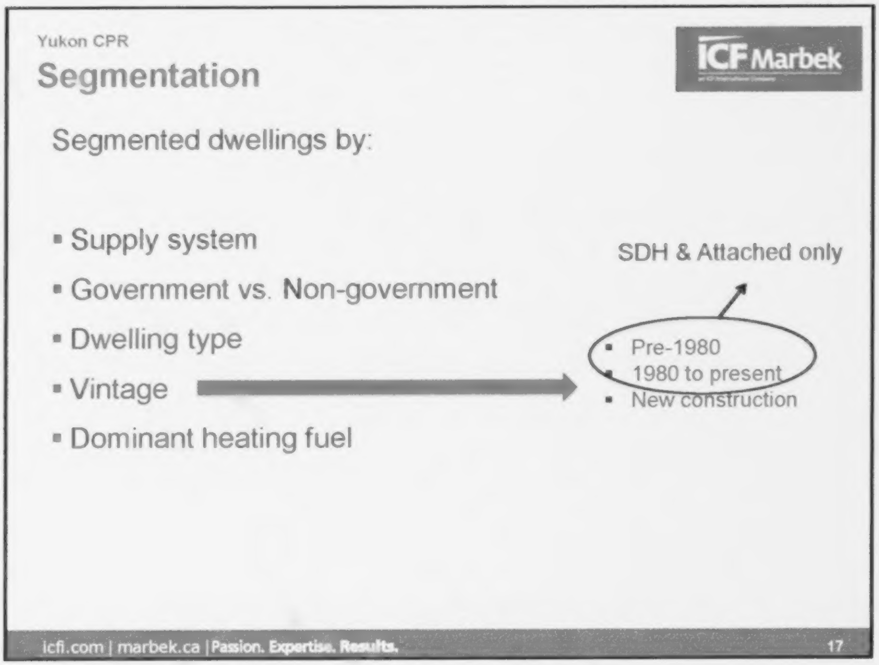

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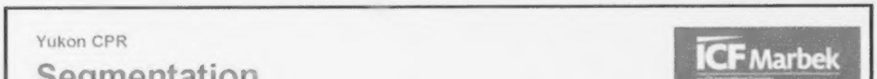
Segmentation

Segmented dwellings by:

- Supply system
- Government vs. Non-government
- Dwelling type
- Vintage
- Dominant heating fuel

SDH & Attached only

- Pre-1980
- 1980 to present
- New construction



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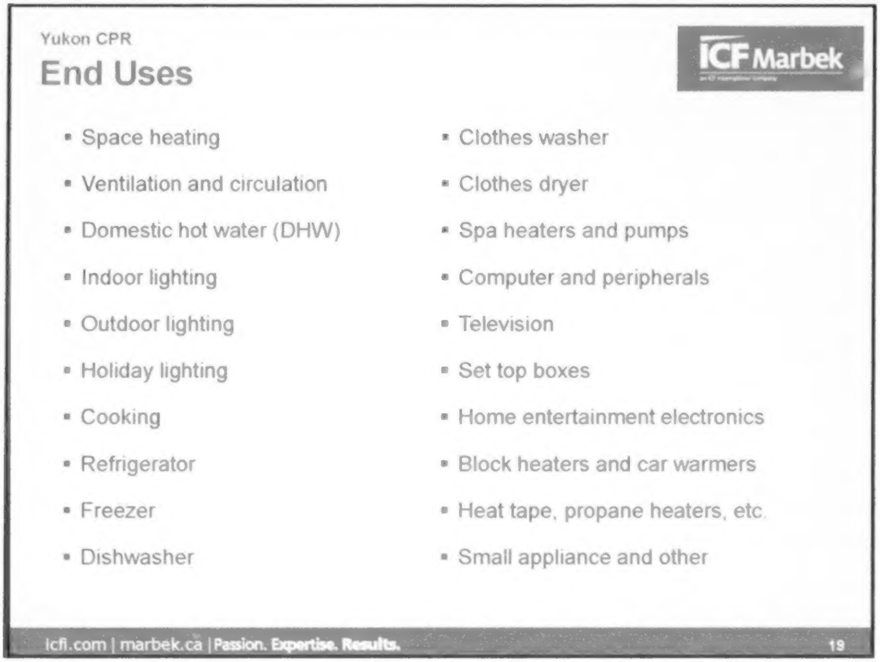
Segmentation

Segmented dwellings by:

- Supply system
- Government vs. Non-government
- Dwelling type
- Vintage
- Primary heating fuel

- Electricity
- Not electricity



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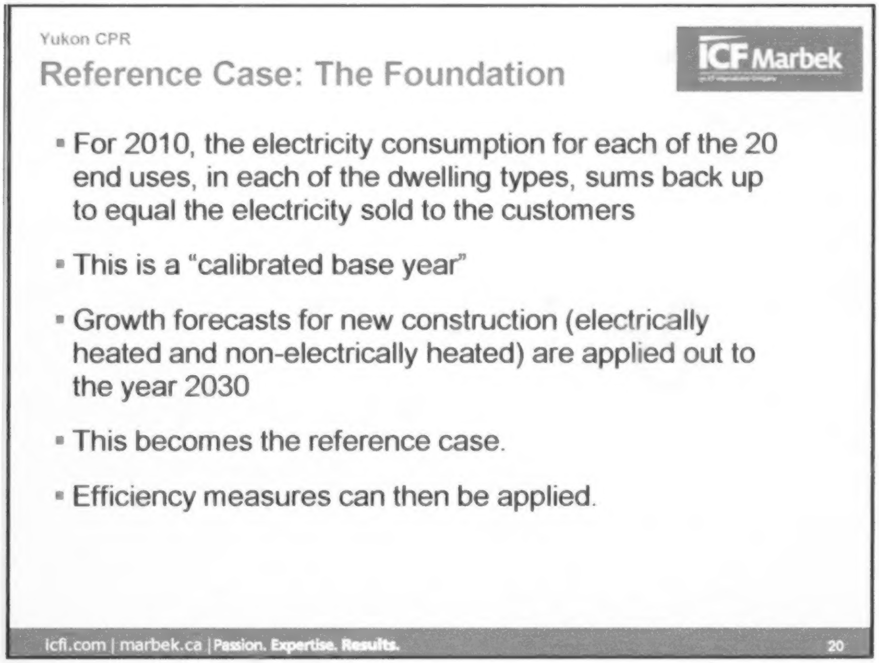
End Uses

- Space heating
- Ventilation and circulation
- Domestic hot water (DHW)
- Indoor lighting
- Outdoor lighting
- Holiday lighting
- Cooking
- Refrigerator
- Freezer
- Dishwasher
- Clothes washer
- Clothes dryer
- Spa heaters and pumps
- Computer and peripherals
- Television
- Set top boxes
- Home entertainment electronics
- Block heaters and car warmers
- Heat tape, propane heaters, etc.
- Small appliance and other



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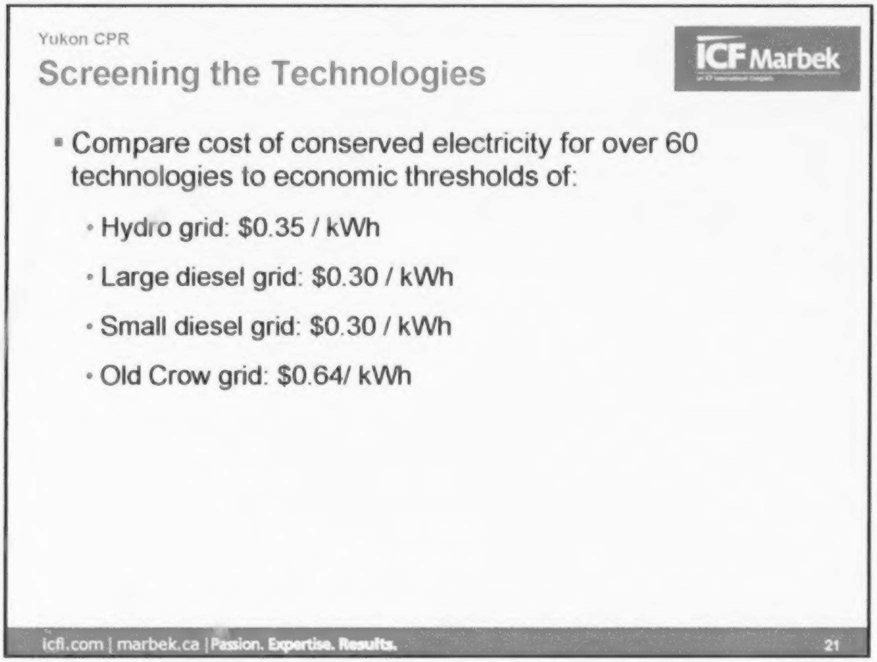
Reference Case: The Foundation

- For 2010, the electricity consumption for each of the 20 end uses, in each of the dwelling types, sums back up to equal the electricity sold to the customers
- This is a "calibrated base year"
- Growth forecasts for new construction (electrically heated and non-electrically heated) are applied out to the year 2030
- This becomes the reference case.
- Efficiency measures can then be applied.



Screening the Technologies

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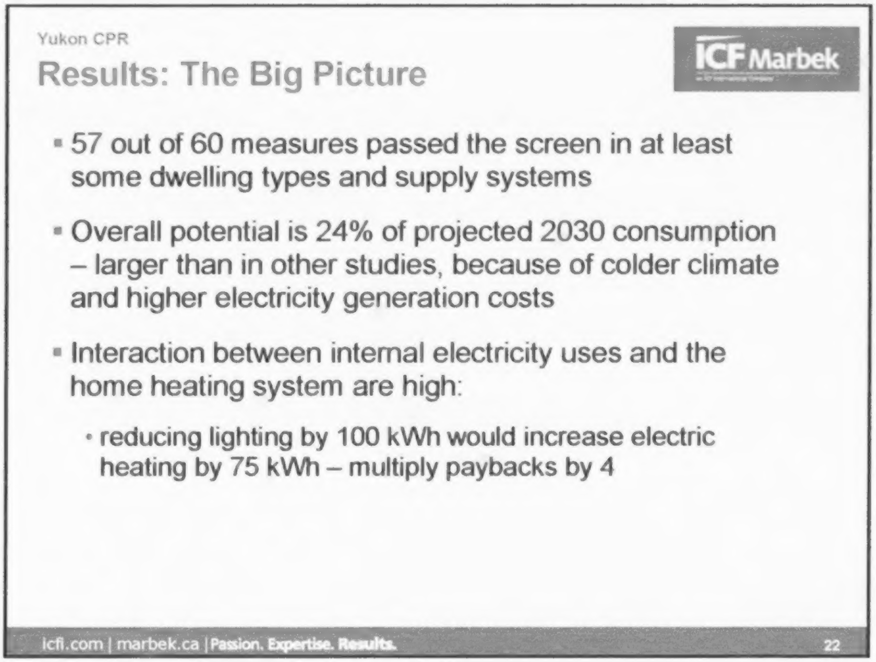
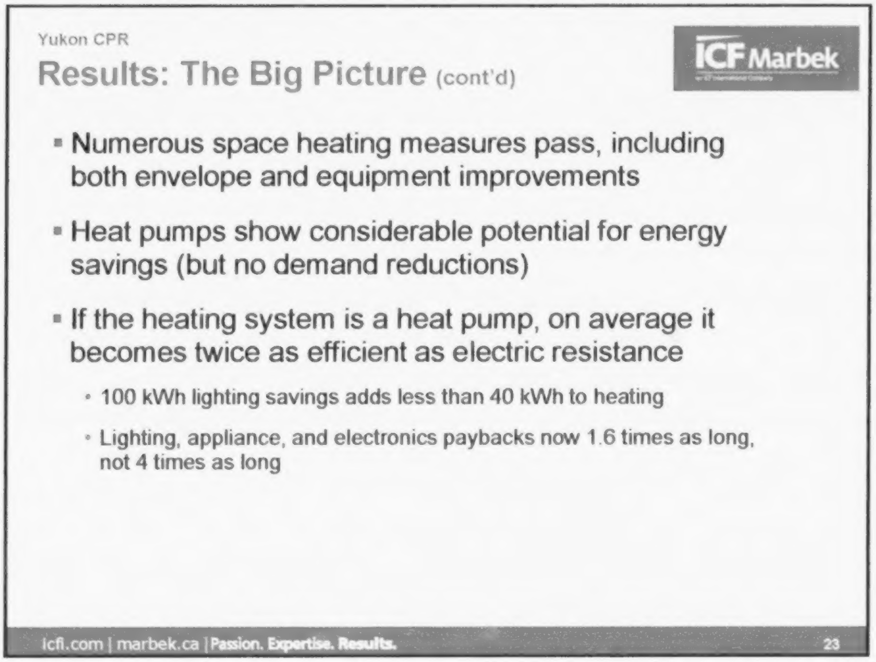
- Compare cost of conserved electricity for over 60 technologies to economic thresholds of:
  - Hydro grid: $0.35 / kWh
  - Large diesel grid: $0.30 / kWh
  - Small diesel grid: $0.30 / kWh
  - Old Crow grid: $0.64/ kWh



Results: The Big Picture

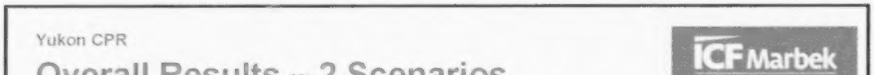
ICF Marbek

- 57 out of 60 measures passed the screen in at least some dwelling types and supply systems
- Overall potential is 24% of projected 2030 consumption – larger than in other studies, because of colder climate and higher electricity generation costs
- Interaction between internal electricity uses and the home heating system are high:
  - reducing lighting by 100 kWh would increase electric heating by 75 kWh – multiply paybacks by 4

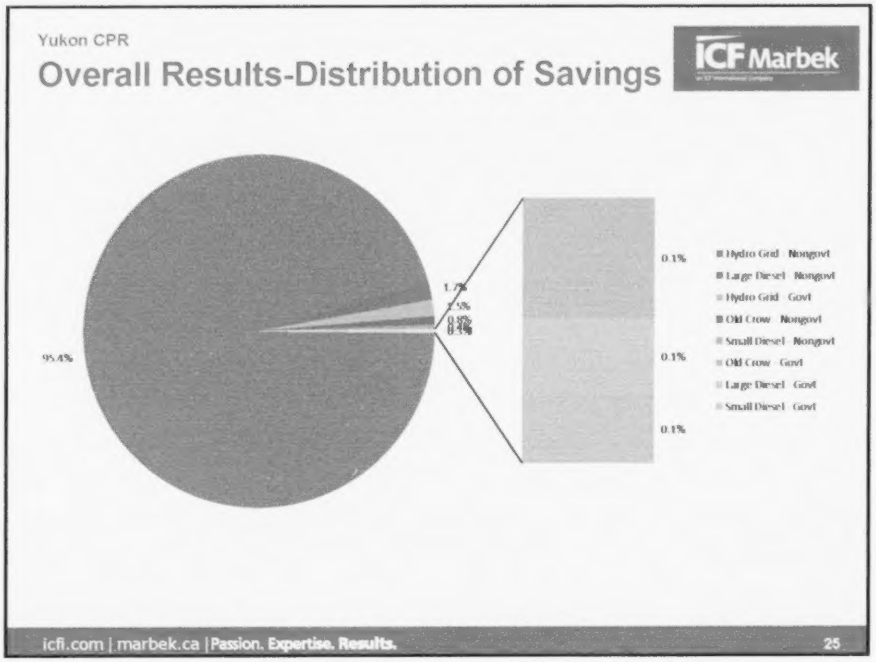


Results: The Big Picture (cont'd)

- Numerous space heating measures pass, including both envelope and equipment improvements
- Heat pumps show considerable potential for energy savings (but no demand reductions)
- If the heating system is a heat pump, on average it becomes twice as efficient as electric resistance
  - 100 kWh lighting savings adds less than 40 kWh to heating
  - Lighting, appliance, and electronics paybacks now 1.6 times as long, not 4 times as long



Overall Results – 2 Scenarios



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Overall Results-Distribution of Savings

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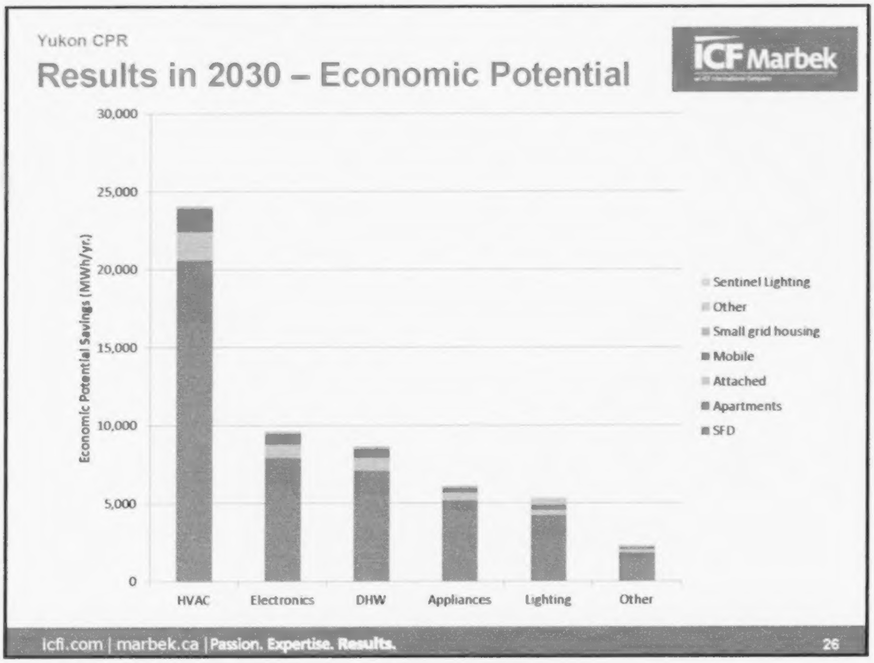

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Results in 2030 – Economic Potential

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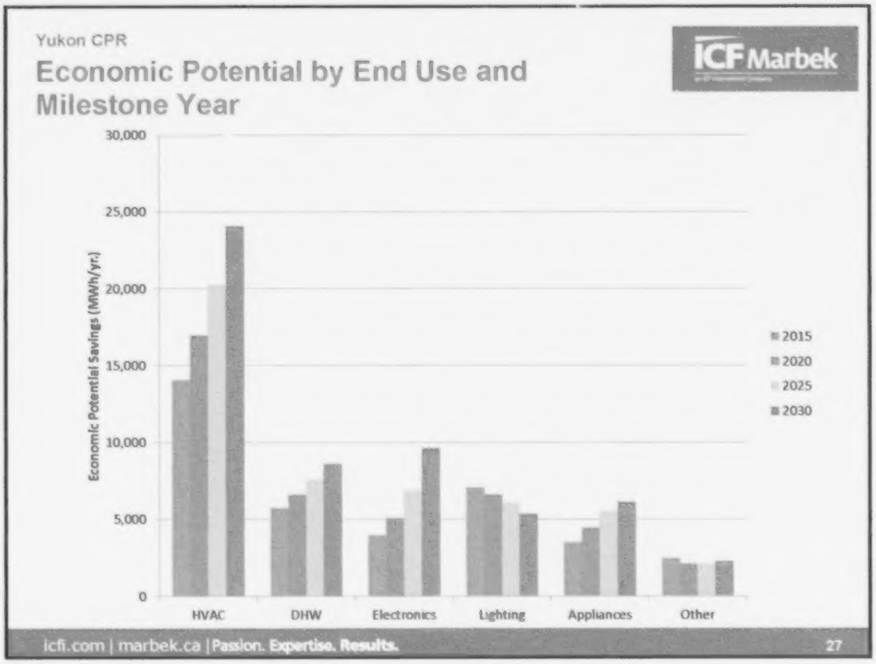

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Economic Potential by End Use and Milestone Year

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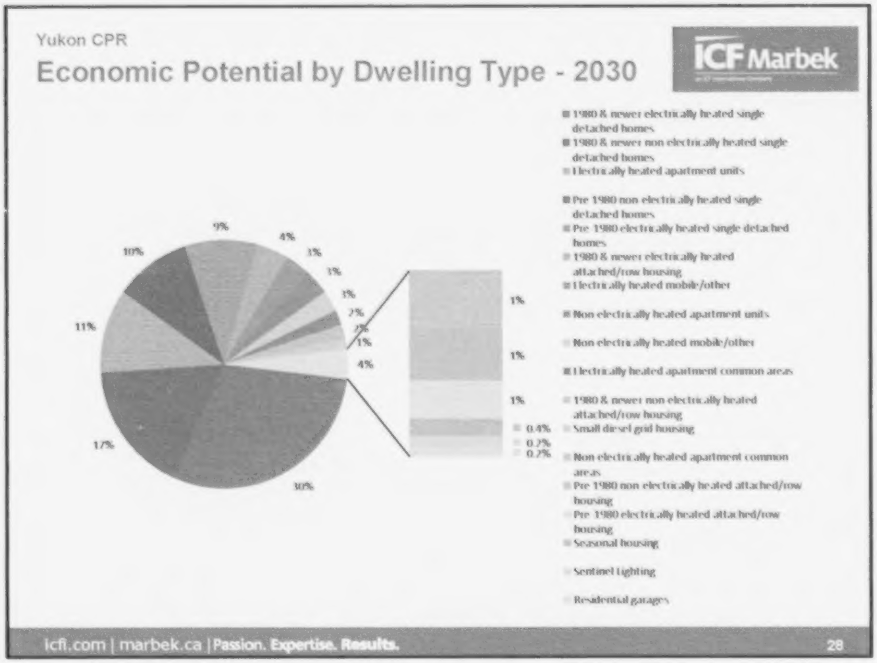

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Economic Potential by Dwelling Type - 2030

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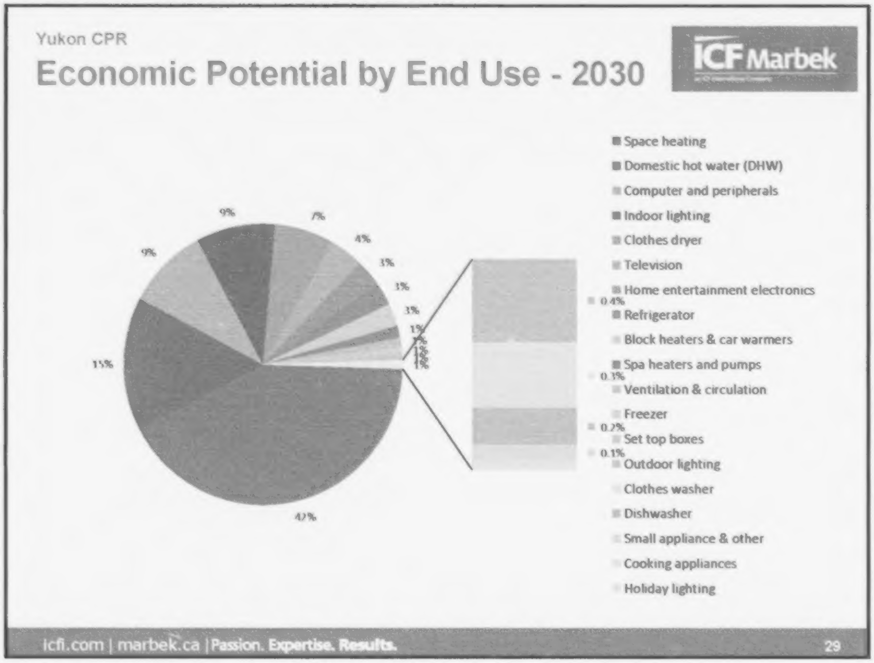

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Economic Potential by End Use - 2030

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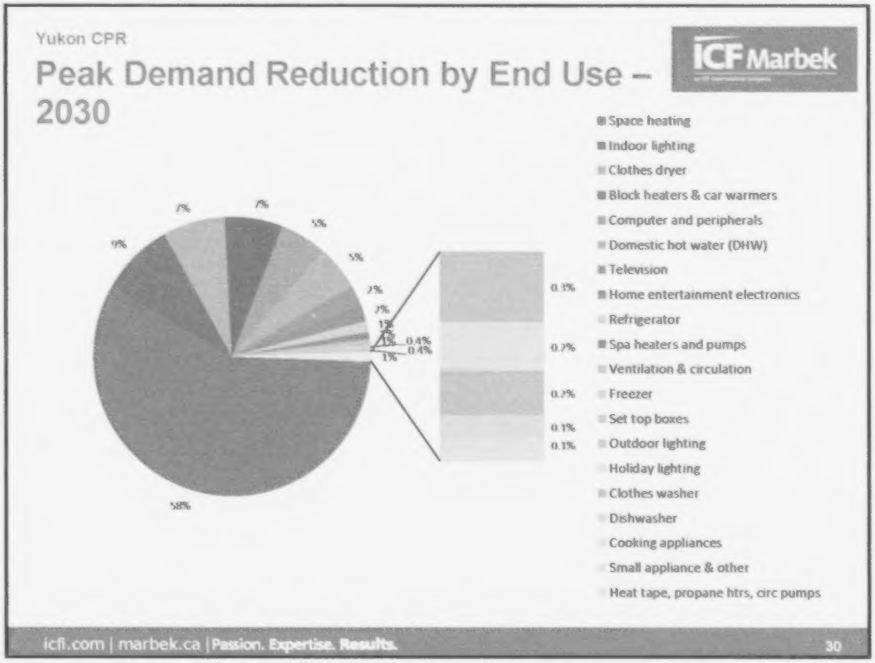

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Peak Demand Reduction by End Use – 2030

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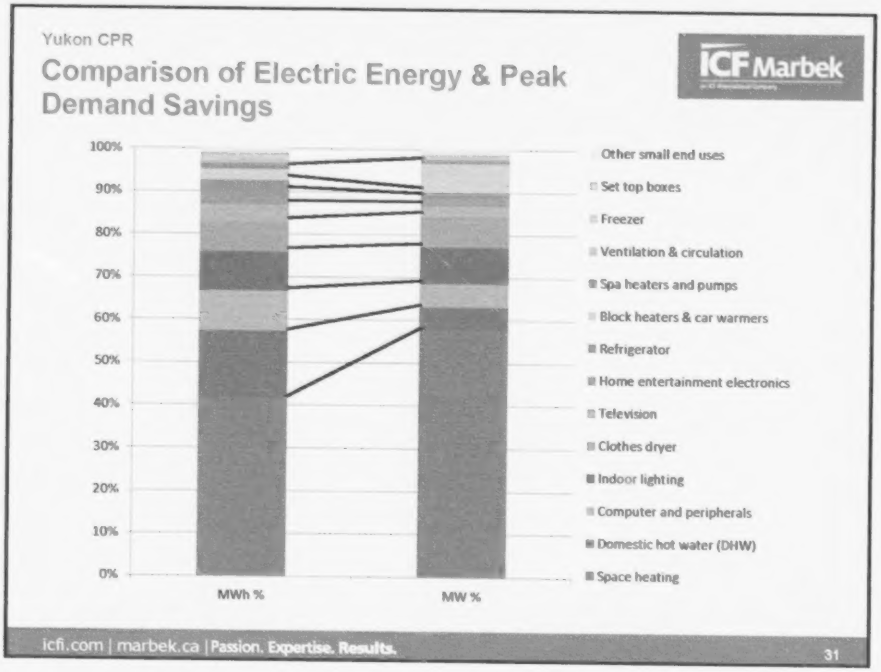

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Comparison of Electric Energy & Peak Demand Savings

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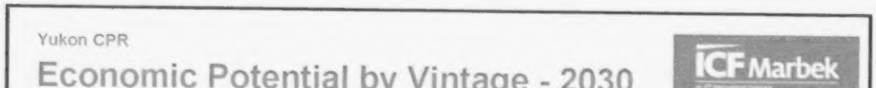

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Economic Potential by Vintage - 2030

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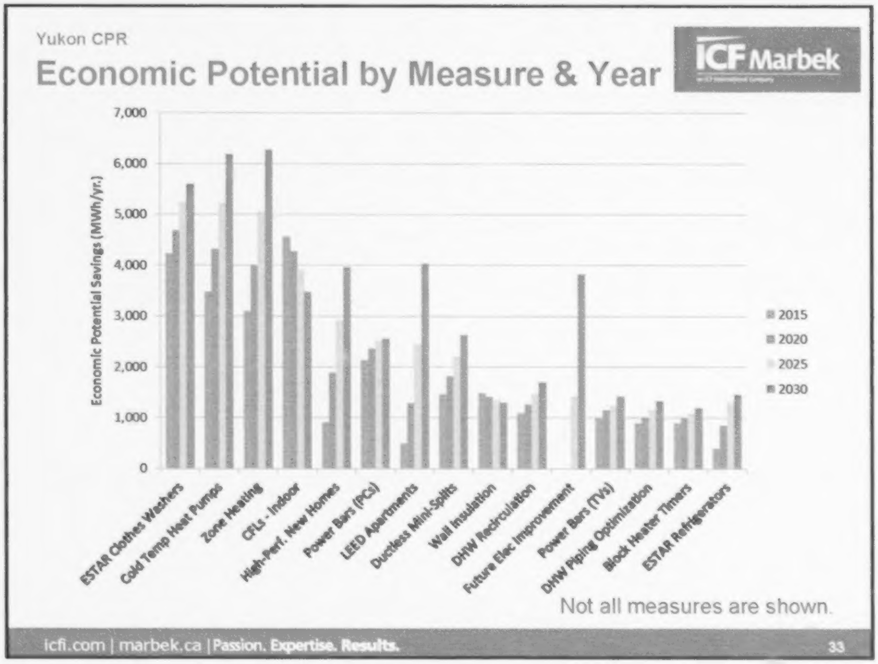

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Economic Potential by Measure & Year

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Not all measures are shown.

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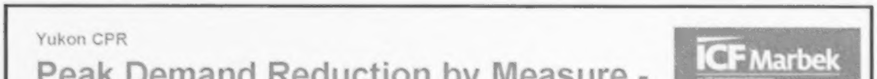

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Peak Demand Reduction by Measure - 2030

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Not all measures are shown.

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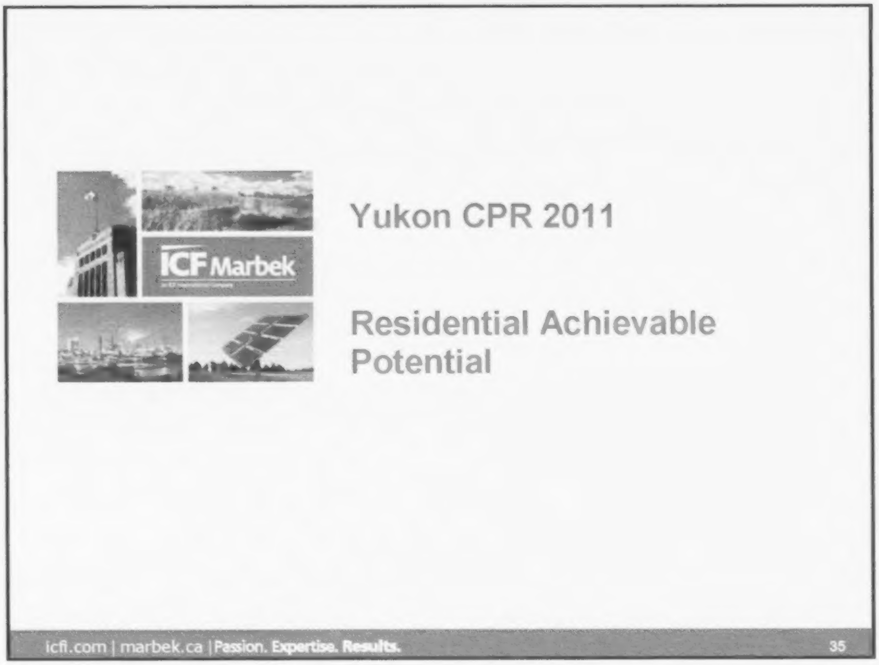

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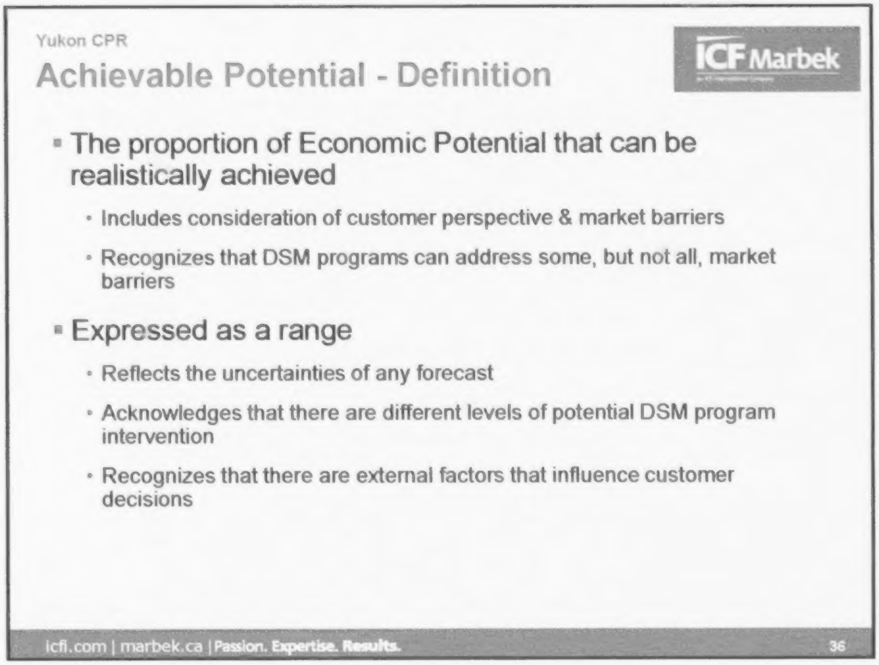
Residential Achievable Potential



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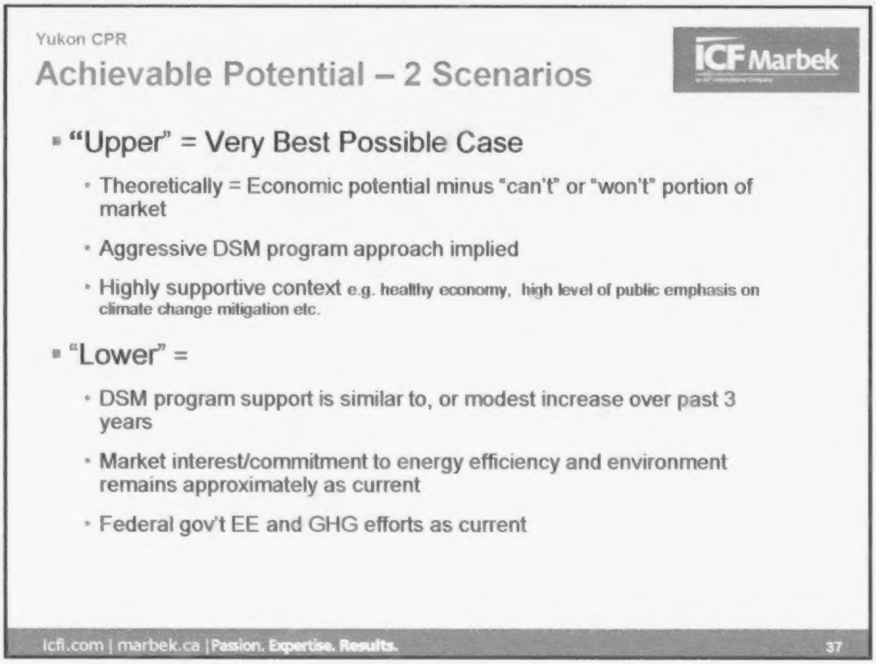
Achievable Potential - Definition

- The proportion of Economic Potential that can be realistically achieved
  - Includes consideration of customer perspective & market barriers
  - Recognizes that DSM programs can address some, but not all, market barriers
- Expressed as a range
  - Reflects the uncertainties of any forecast
  - Acknowledges that there are different levels of potential DSM program intervention
  - Recognizes that there are external factors that influence customer decisions



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Achievable Potential – 2 Scenarios

- "Upper" = Very Best Possible Case
  - Theoretically = Economic potential minus "can't" or "won't" portion of market
  - Aggressive DSM program approach implied
  - Highly supportive context e.g. healthy economy, high level of public emphasis on climate change mitigation etc.
- "Lower" =
  - DSM program support is similar to, or modest increase over past 3 years
  - Market interest/commitment to energy efficiency and environment remains approximately as current
  - Federal gov't EE and GHG efforts as current

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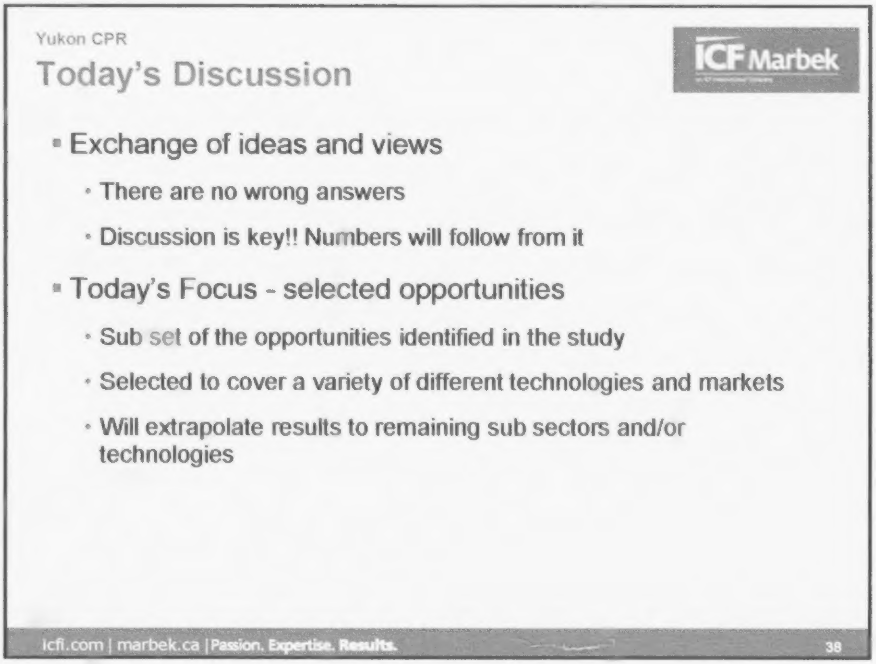

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Today's Discussion

- Exchange of ideas and views
  - There are no wrong answers
  - Discussion is key!! Numbers will follow from it
- Today's Focus - selected opportunities
  - Sub set of the opportunities identified in the study
  - Selected to cover a variety of different technologies and markets
  - Will extrapolate results to remaining sub sectors and/or technologies

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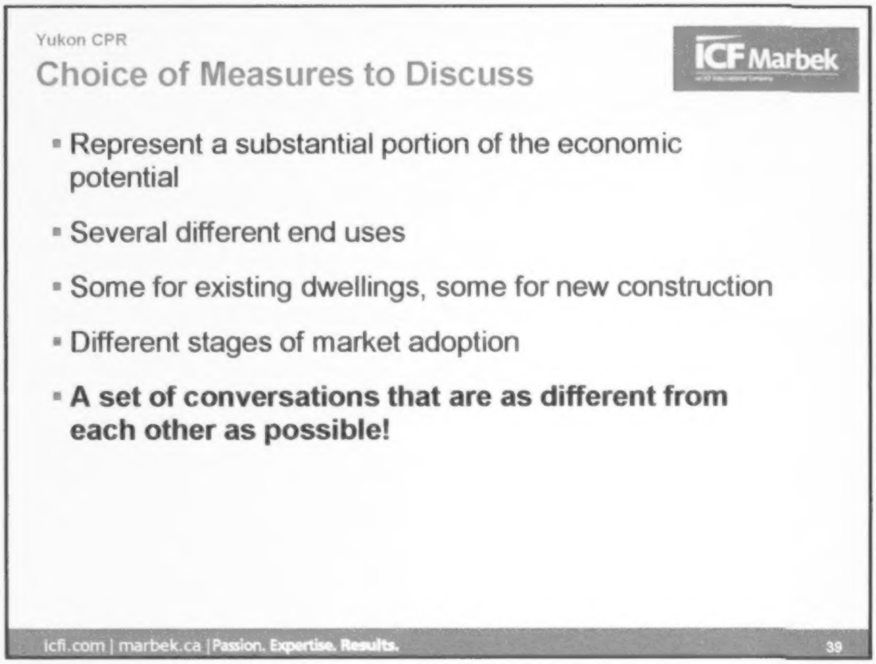
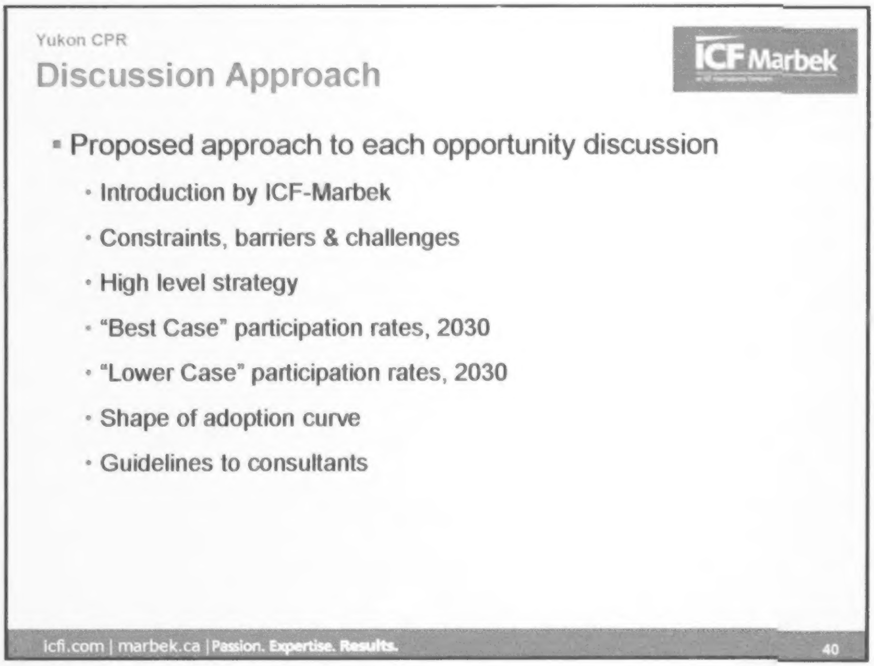


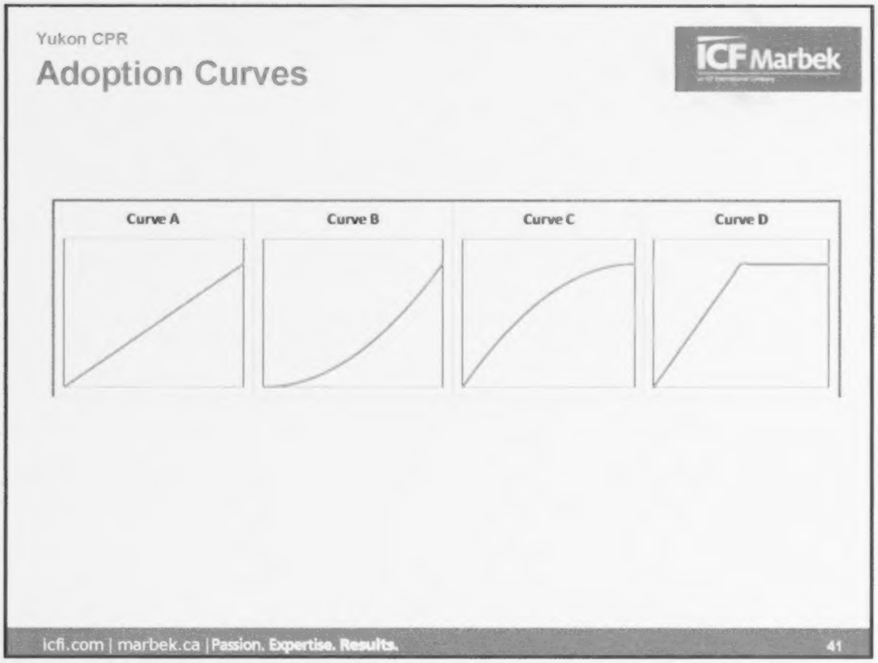
Choice of Measures to Discuss

- Represent a substantial portion of the economic potential
- Several different end uses
- Some for existing dwellings, some for new construction
- Different stages of market adoption
- **A set of conversations that are as different from each other as possible!**



Discussion Approach

- Proposed approach to each opportunity discussion
  - Introduction by ICF-Marbek
  - Constraints, barriers & challenges
  - High level strategy
  - "Best Case" participation rates, 2030
  - "Lower Case" participation rates, 2030
  - Shape of adoption curve
  - Guidelines to consultants



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Adoption Curves

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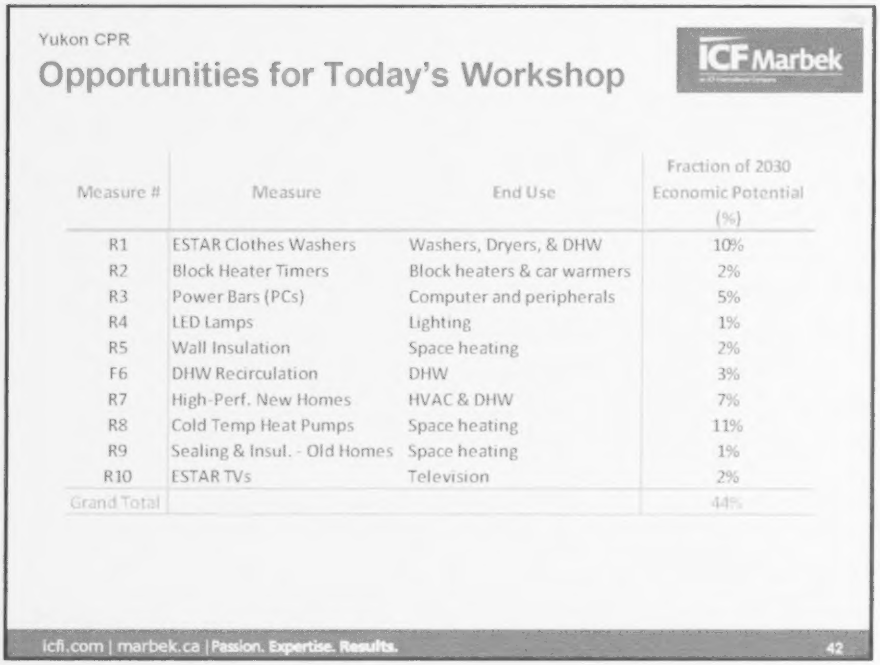

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Opportunities for Today's Workshop

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Measure #	Measure	End Use	Fraction of 2030 Economic Potential (%)
R1	ESTAR Clothes Washers	Washers, Dryers, & DHW	10%
R2	Block Heater Timers	Block heaters & car warmers	2%
R3	Power Bars (PCs)	Computer and peripherals	5%
R4	LED Lamps	Lighting	1%
R5	Wall Insulation	Space heating	2%
F6	DHW Recirculation	DHW	3%
R7	High-Perf. New Homes	HVAC & DHW	7%
R8	Cold Temp Heat Pumps	Space heating	11%
R9	Sealing & Insul. - Old Homes	Space heating	1%
R10	ESTAR TVs	Television	2%
Grand Total			44%

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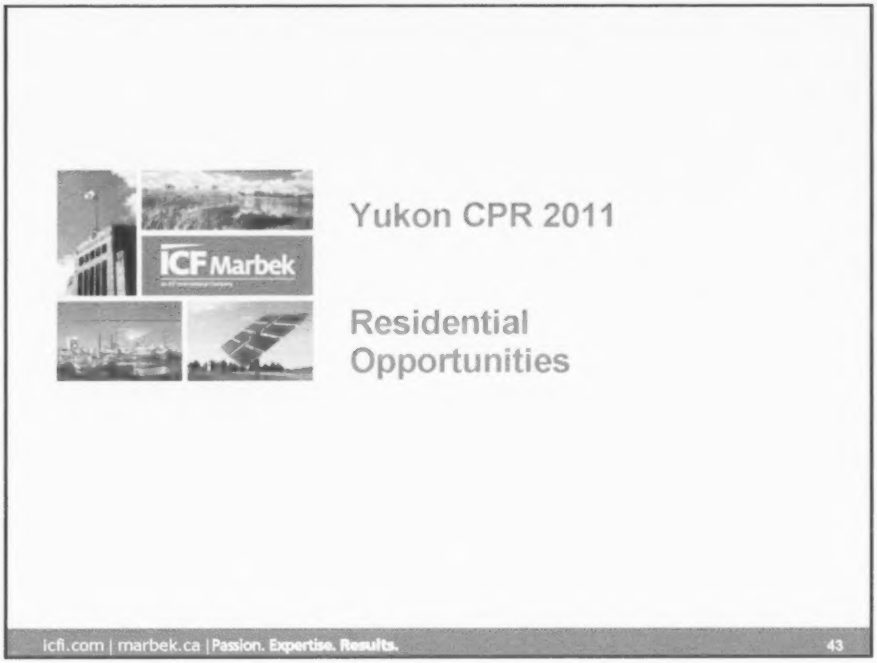

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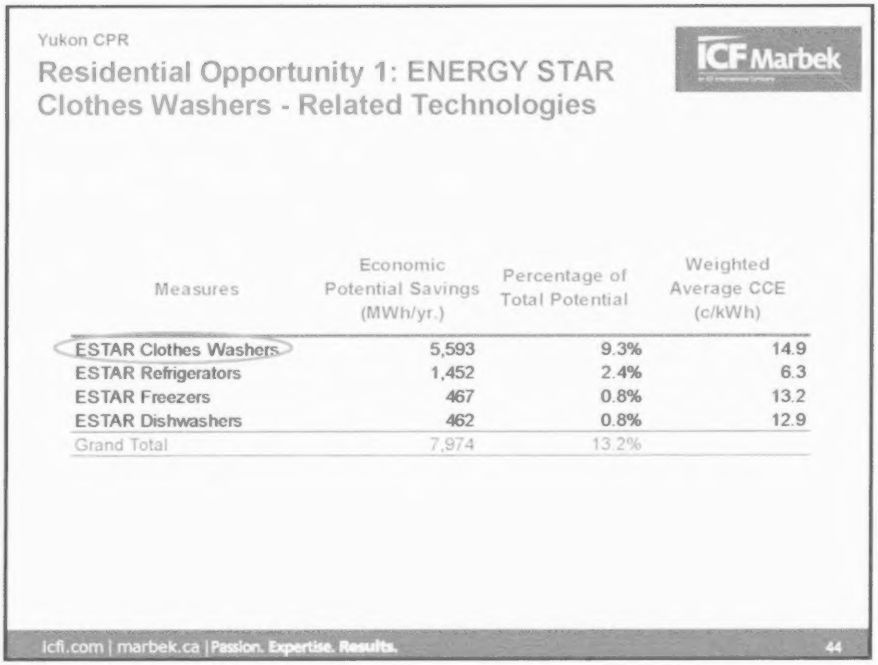
Residential Opportunities



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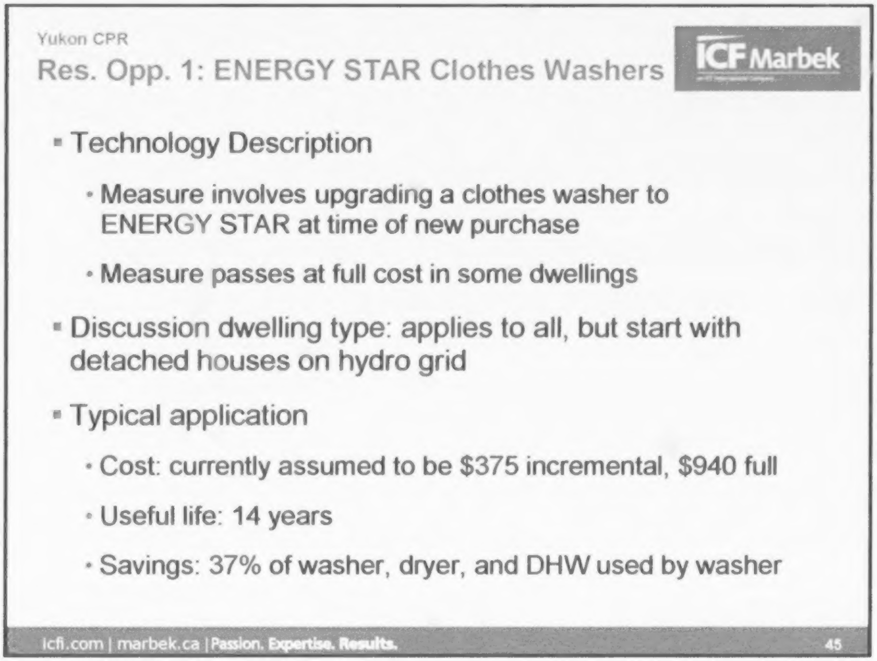
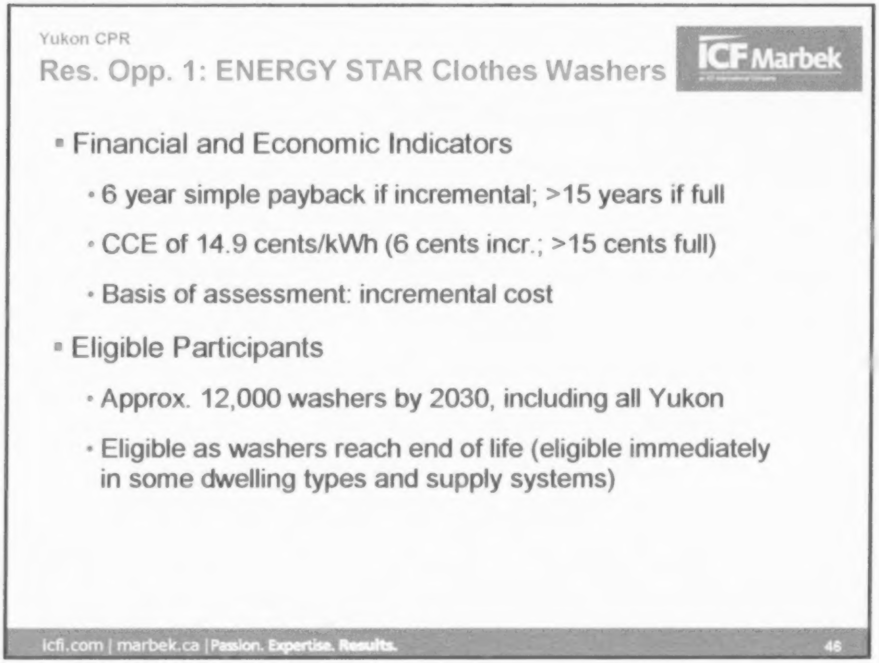
Residential Opportunity 1: ENERGY STAR Clothes Washers - Related Technologies

Measures	Economic Potential Savings (MWh/yr.)	Percentage of Total Potential	Weighted Average CCE (c/kWh)
ESTAR Clothes Washers	5,593	9.3%	14.9
ESTAR Refrigerators	1,452	2.4%	6.3
ESTAR Freezers	467	0.8%	13.2
ESTAR Dishwashers	462	0.8%	12.9
Grand Total	7,974	13.2%	



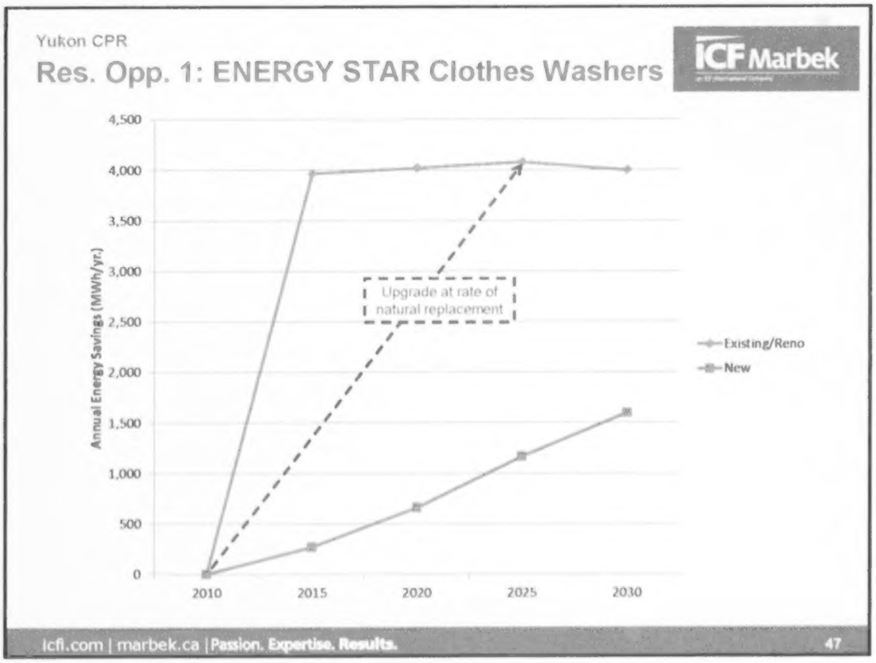
Res. Opp. 1: ENERGY STAR Clothes Washers

- Technology Description
  - Measure involves upgrading a clothes washer to ENERGY STAR at time of new purchase
  - Measure passes at full cost in some dwellings
- Discussion dwelling type: applies to all, but start with detached houses on hydro grid
- Typical application
  - Cost: currently assumed to be $375 incremental, $940 full
  - Useful life: 14 years
  - Savings: 37% of washer, dryer, and DHW used by washer



Res. Opp. 1: ENERGY STAR Clothes Washers

- Financial and Economic Indicators
  - 6 year simple payback if incremental; >15 years if full
  - CCE of 14.9 cents/kWh (6 cents incr.; >15 cents full)
  - Basis of assessment: incremental cost
- Eligible Participants
  - Approx. 12,000 washers by 2030, including all Yukon
  - Eligible as washers reach end of life (eligible immediately in some dwelling types and supply systems)



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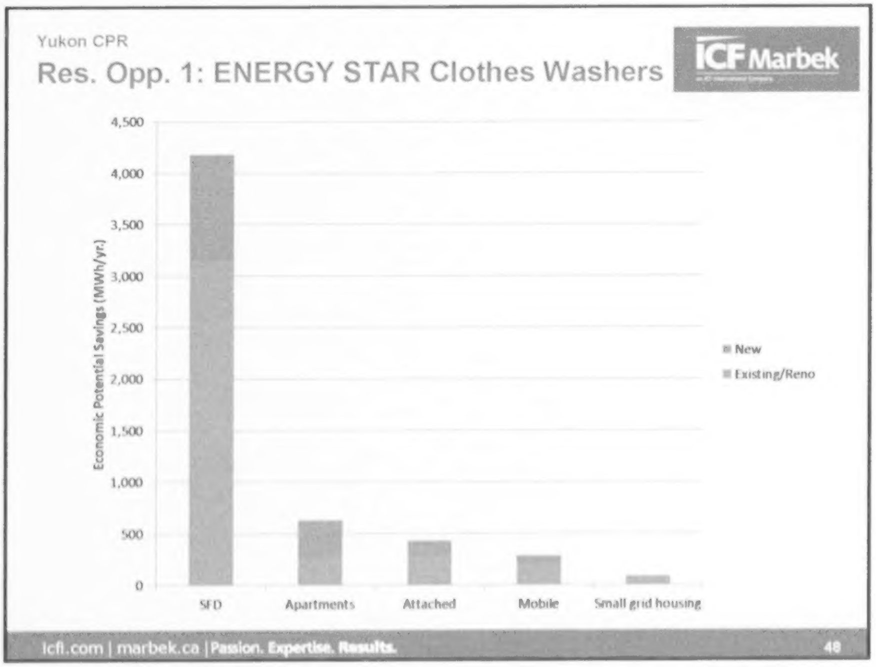
Res. Opp. 1: ENERGY STAR Clothes Washers



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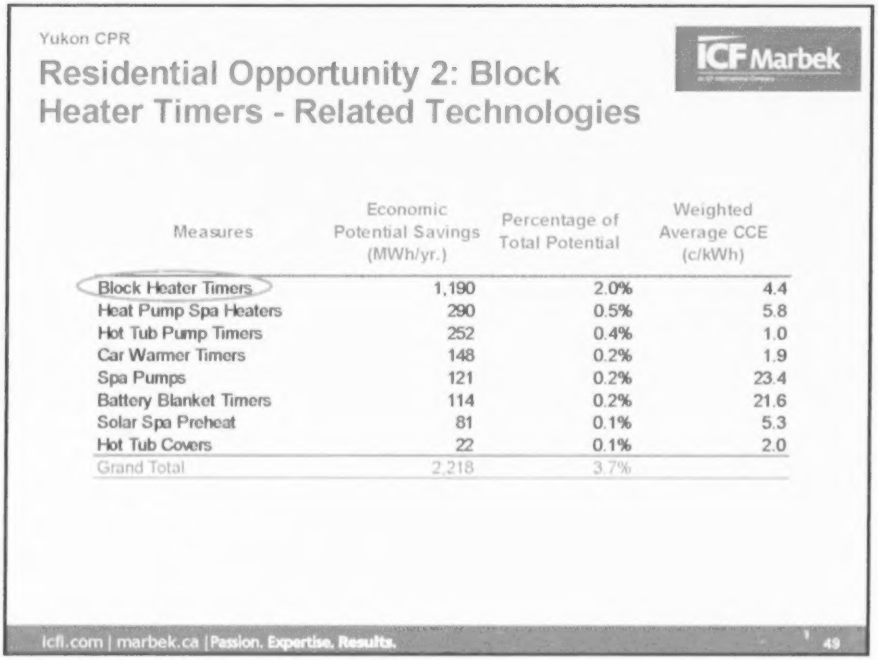
Res. Opp. 1: ENERGY STAR Clothes Washers



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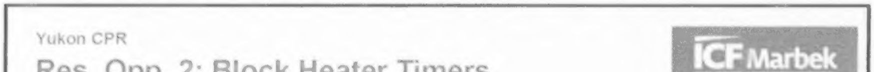
Residential Opportunity 2: Block Heater Timers - Related Technologies

Measures	Economic Potential Savings (MWh/yr.)	Percentage of Total Potential	Weighted Average CCE (c/kWh)
Block Heater Timers	1,190	2.0%	4.4
Heat Pump Spa Heaters	290	0.5%	5.8
Hot Tub Pump Timers	252	0.4%	1.0
Car Warmer Timers	148	0.2%	1.9
Spa Pumps	121	0.2%	23.4
Battery Blanket Timers	114	0.2%	21.6
Solar Spa Preheat	81	0.1%	5.3
Hot Tub Covers	22	0.1%	2.0
Grand Total	2,218	3.7%	



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Res. Opp. 2: Block Heater Timers

- Technology Description
  - Timer to reduce block heater runtime to 4 hours/day
  - Likely reduces evening block heater demand by 90%
- Discussion dwelling type: applies to all, but start with detached houses on hydro grid
- Typical application
  - Cost: currently assumed to be $37.50 each
  - Useful life: 10 years
  - Savings: 40% energy and 90% peak demand reduction

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Res. Opp. 2: Block Heater Timers

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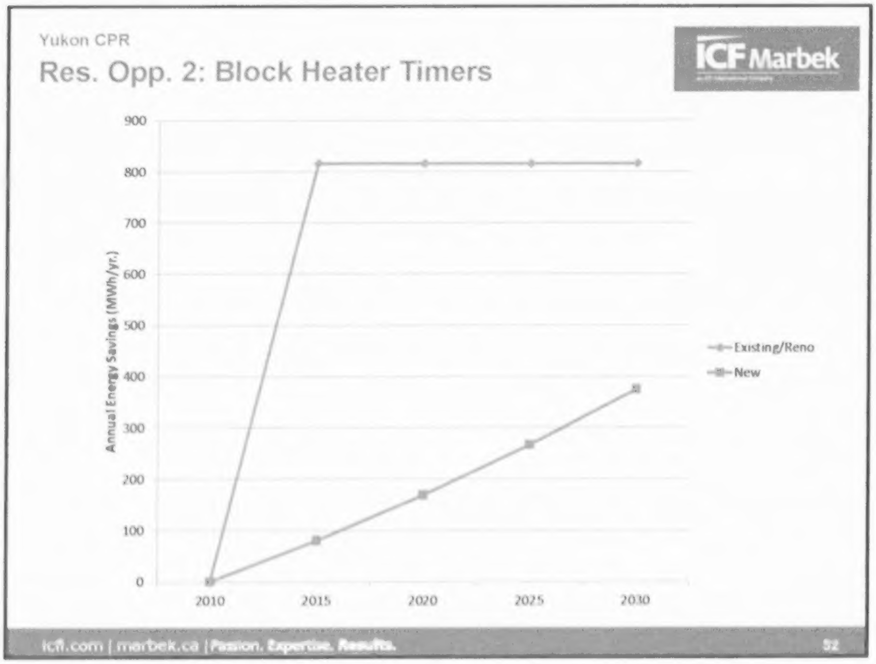
- Financial and Economic Indicators
  - 4 year simple payback
  - CCE of 4.4 cents/kWh
  - Basis of assessment: full cost
- Eligible Participants
  - Approx. 10,000 dwellings by 2030, including all Yukon
  - Eligible immediately



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Res. Opp. 2: Block Heater Timers

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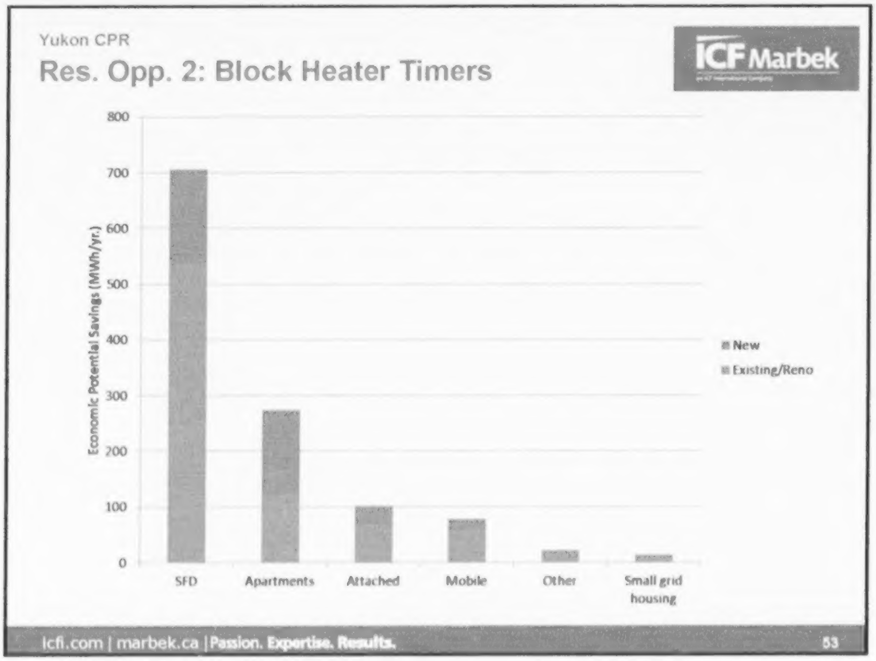

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Res. Opp. 2: Block Heater Timers

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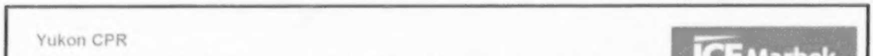

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Residential Opportunity 3: Power Bars for PCs - Related Technologies

Measures	Economic Potential Savings (MWh/yr.)	Percentage of Total Potential	Weighted Average CCE (c/kWh)
Future Elec Improvement	3,819	6.3%	11.5
Power Bars (PCs)	2,548	4.2%	8.4
Power Bars (TVs)	1,424	2.4%	14.0
ESTAR TVs	905	1.5%	24.1
ESTAR Printers and Fax	849	1.4%	15.9
Grand Total	9,545	15.8%	

(Opportunity #10)

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Res. Opp. 3: Power Bars for PCs

- Technology Description
  - Measure involves using power bars with timers and/or sensors to reduce phantom loads from computer equipment
- Discussion dwelling type: applies to all, but start with detached houses on hydro grid
- Typical application
  - Cost: currently assumed to be $50 each
  - Useful life: 10 years
  - Savings: 20% of computer and peripheral electricity use

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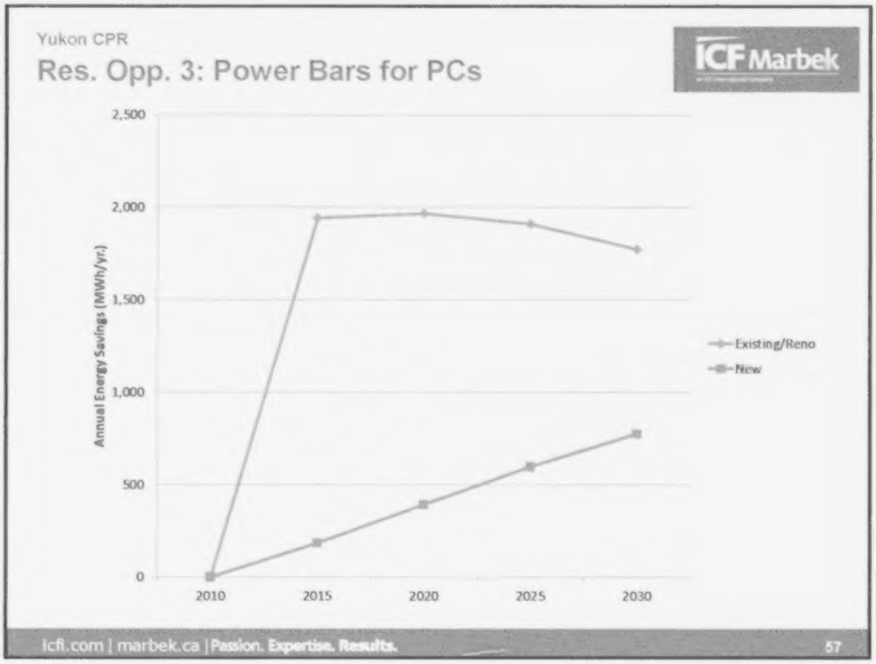
Res. Opp. 3: Power Bars for PCs

- Financial and Economic Indicators
  - 6 year simple payback
  - CCE of 8.4 cents/kWh
  - Basis of assessment: full cost
- Eligible Participants
  - Approx. 30,000 computers by 2030, including all Yukon (more than one computer per dwelling)
  - Eligible immediately



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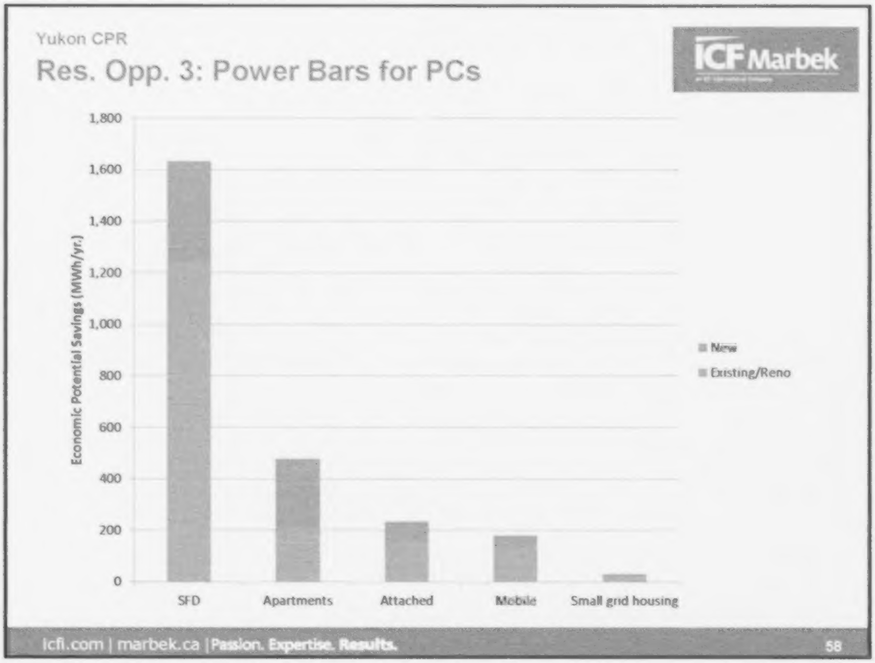
Res. Opp. 3: Power Bars for PCs



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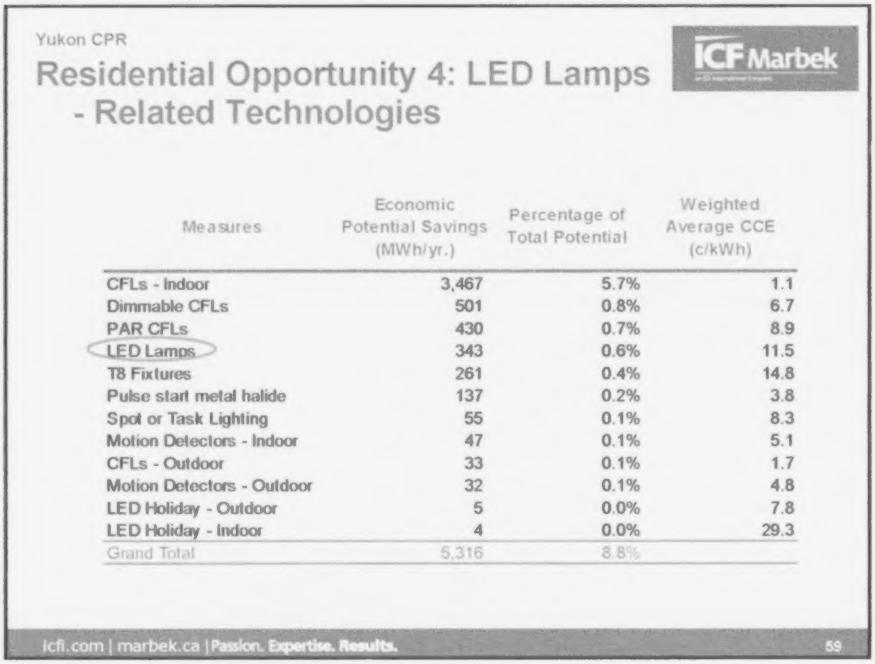
Res. Opp. 3: Power Bars for PCs



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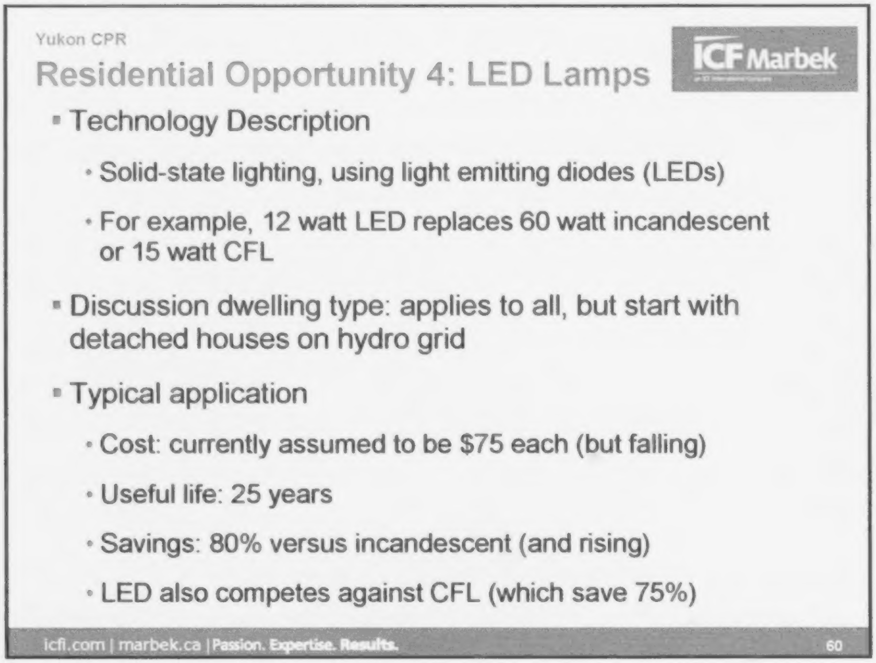
Residential Opportunity 4: LED Lamps - Related Technologies

Measures	Economic Potential Savings (MWh/yr.)	Percentage of Total Potential	Weighted Average CCE (c/kWh)
CFLs - Indoor	3,467	5.7%	1.1
Dimmable CFLs	501	0.8%	6.7
PAR CFLs	430	0.7%	8.9
LED Lamps	343	0.6%	11.5
T8 Fixtures	261	0.4%	14.8
Pulse start metal halide	137	0.2%	3.8
Spot or Task Lighting	55	0.1%	8.3
Motion Detectors - Indoor	47	0.1%	5.1
CFLs - Outdoor	33	0.1%	1.7
Motion Detectors - Outdoor	32	0.1%	4.8
LED Holiday - Outdoor	5	0.0%	7.8
LED Holiday - Indoor	4	0.0%	29.3
Grand Total	5,316	8.8%	



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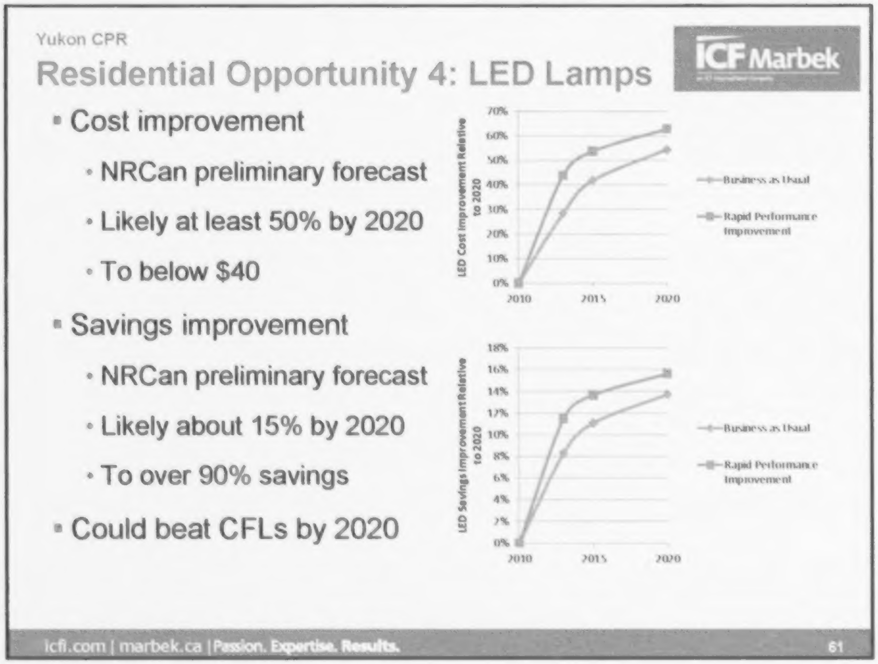
Residential Opportunity 4: LED Lamps

- Technology Description
  - Solid-state lighting, using light emitting diodes (LEDs)
  - For example, 12 watt LED replaces 60 watt incandescent or 15 watt CFL
- Discussion dwelling type: applies to all, but start with detached houses on hydro grid
- Typical application
  - Cost: currently assumed to be $75 each (but falling)
  - Useful life: 25 years
  - Savings: 80% versus incandescent (and rising)
  - LED also competes against CFL (which save 75%)



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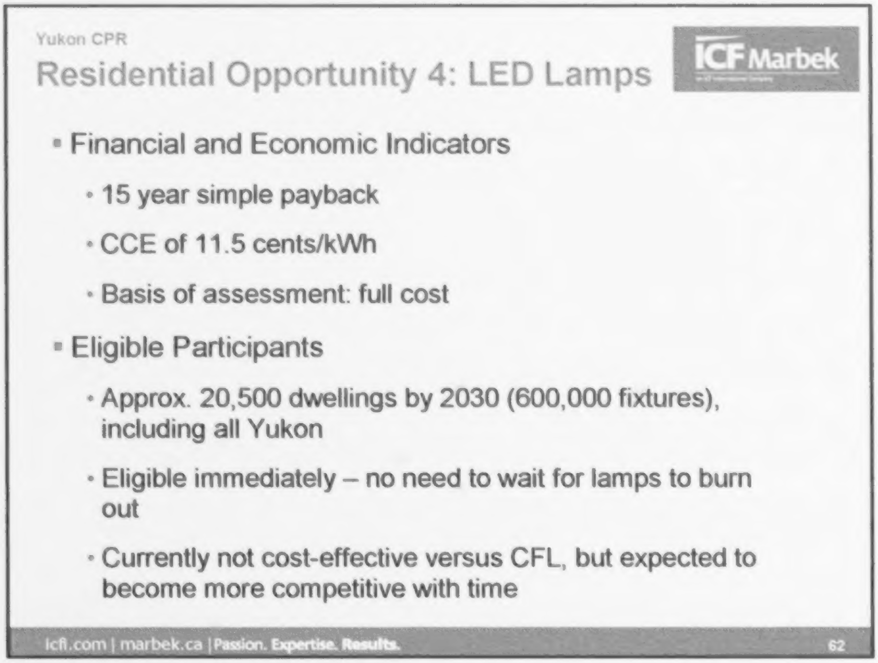
Residential Opportunity 4: LED Lamps

- Cost improvement
  - NRCan preliminary forecast
  - Likely at least 50% by 2020
  - To below $40
- Savings improvement
  - NRCan preliminary forecast
  - Likely about 15% by 2020
  - To over 90% savings
- Could beat CFLs by 2020



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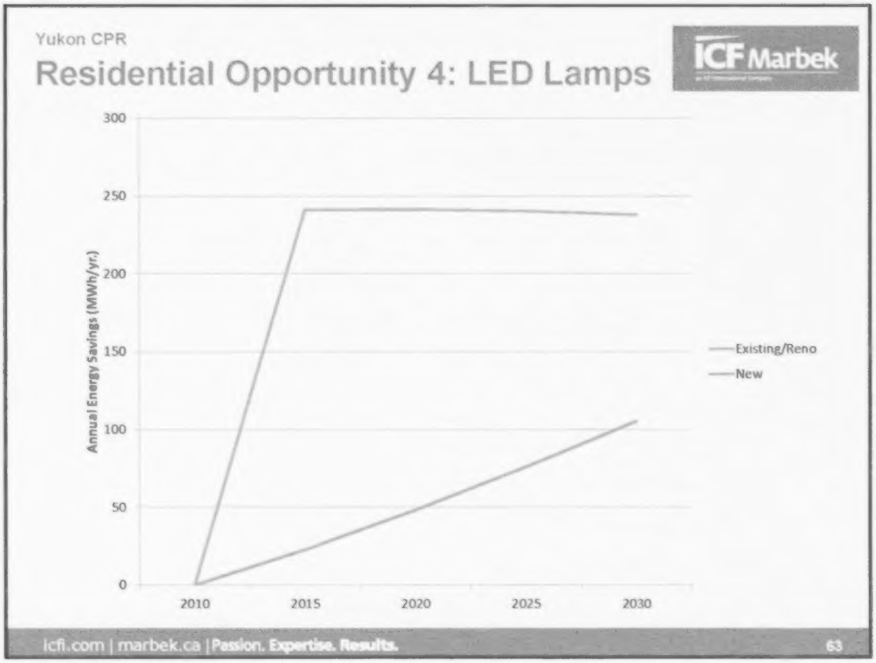
Residential Opportunity 4: LED Lamps

- Financial and Economic Indicators
  - 15 year simple payback
  - CCE of 11.5 cents/kWh
  - Basis of assessment: full cost
- Eligible Participants
  - Approx. 20,500 dwellings by 2030 (600,000 fixtures), including all Yukon
  - Eligible immediately – no need to wait for lamps to burn out
  - Currently not cost-effective versus CFL, but expected to become more competitive with time



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Residential Opportunity 4: LED Lamps

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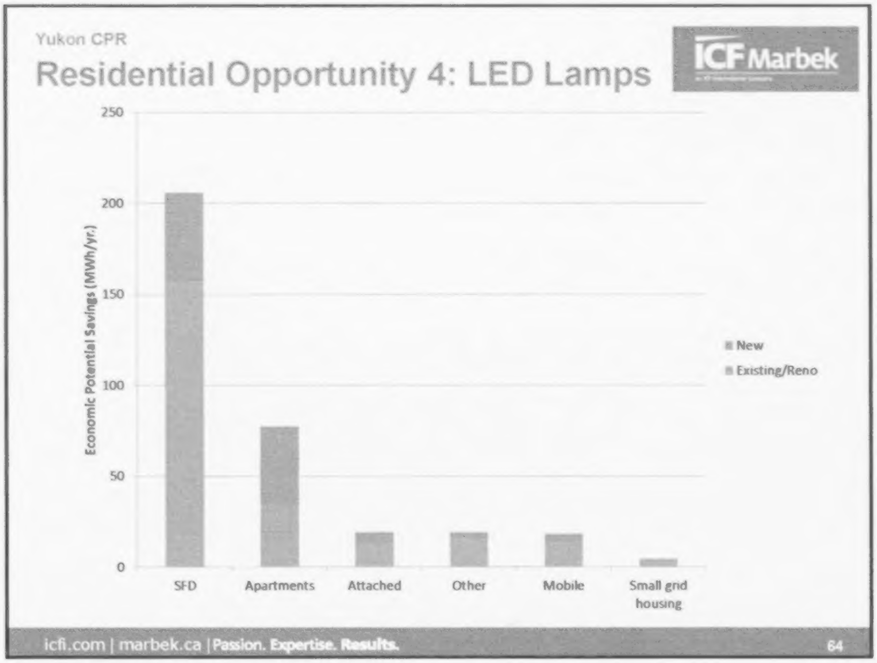

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Residential Opportunity 4: LED Lamps

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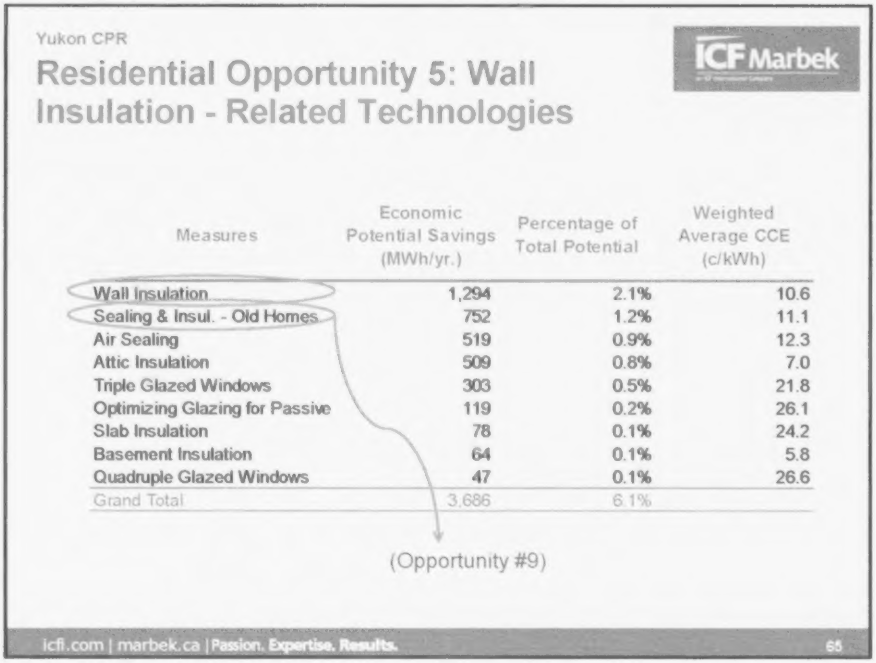

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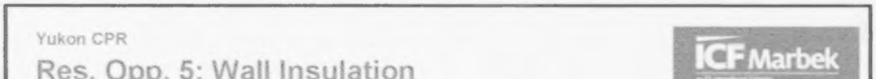
Residential Opportunity 5: Wall Insulation - Related Technologies

Measures	Economic Potential Savings (MWh/yr.)	Percentage of Total Potential	Weighted Average CCE (c/kWh)
Wall Insulation	1,294	2.1%	10.6
Sealing & Insul. - Old Homes	752	1.2%	11.1
Air Sealing	519	0.9%	12.3
Attic Insulation	509	0.8%	7.0
Triple Glazed Windows	303	0.5%	21.8
Optimizing Glazing for Passive	119	0.2%	26.1
Slab Insulation	78	0.1%	24.2
Basement Insulation	64	0.1%	5.8
Quadruple Glazed Windows	47	0.1%	26.6
Grand Total	3,686	6.1%	

(Opportunity #9)



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Res. Opp. 5: Wall Insulation

- Technology Description
  - Increasing wall insulation to RSI 5 (R-28)
  - May be blown in, or added at time of siding replacement
- Discussion dwelling type: applies to all, but start with detached houses on hydro grid
- Typical application
  - Cost: currently assumed to be $3,375, not including cost of siding replacement work (if applicable)
  - Useful life: 30 years
  - Savings: 14.5% of space heating energy

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Res. Opp. 5: Wall Insulation

- Financial and Economic Indicators
  - 14-17 year simple payback
  - CCE of 10.6 cents/kWh on average
  - Basis of assessment: full cost
- Eligible Participants
  - Approx. 600 dwellings by 2030, including all Yukon
  - Includes only electrically heated dwellings
  - Eligible immediately, but easier if siding being replaced
  - Collaborate with other agencies to broaden program beyond electrically heated dwellings?

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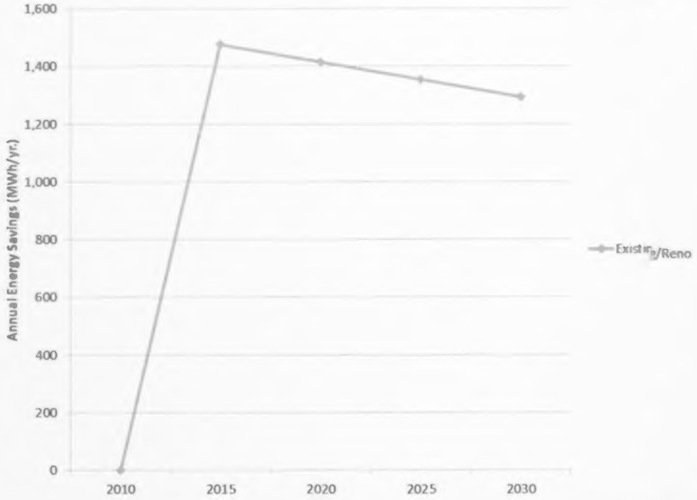
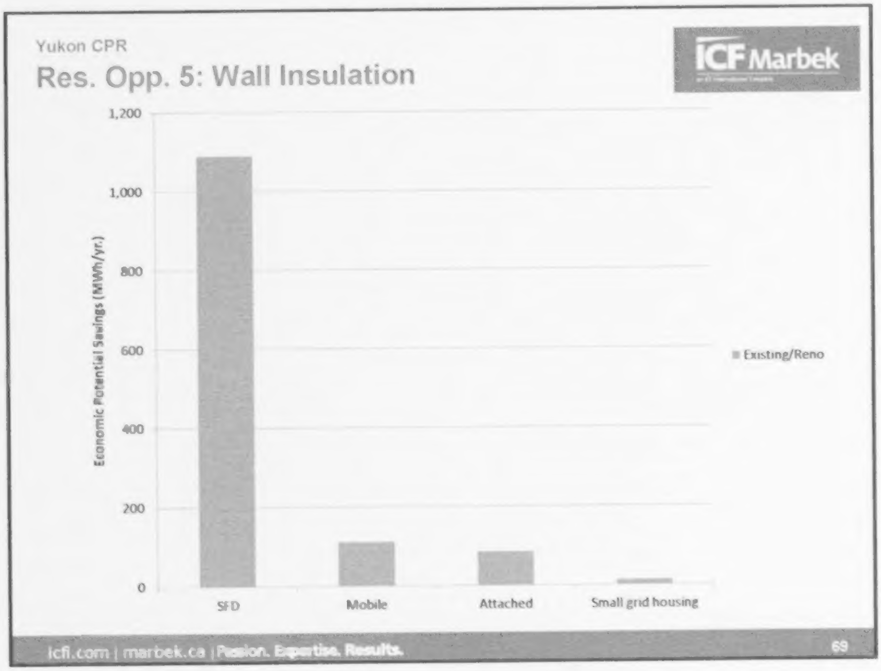
Res. Opp. 5: Wall Insulation





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Res. Opp. 5: Wall Insulation

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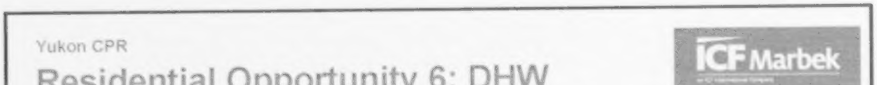

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Residential Opportunity 6: DHW Recirculation - Related Technologies

Measures	Economic Potential Savings (MWh/yr.)	Percentage of Total Potential	Weighted Average CCE (c/kWh)
DHW Recirculation	1,698	2.8%	14.8
DHW Piping Optimization	1,325	2.2%	21.2
Wastewater Heat Recovery	1,073	1.8%	17.4
Showerheads	645	1.1%	0.8
DHW Tank Insulation	389	0.6%	7.6
DHW Pipe Insulation	306	0.5%	0.2
Grand Total	5,436	9.0%	

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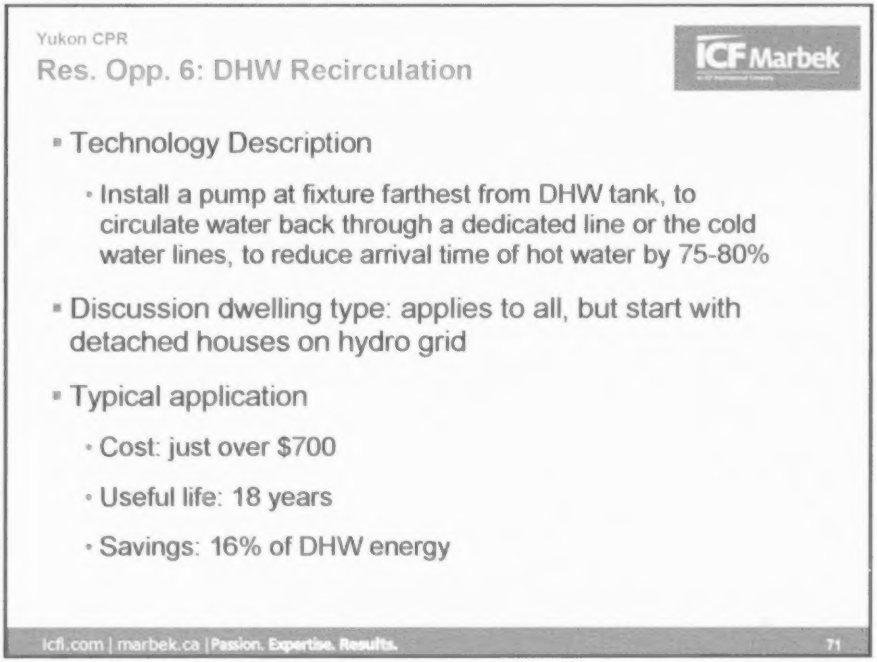
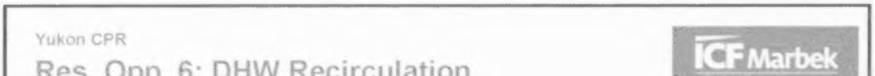


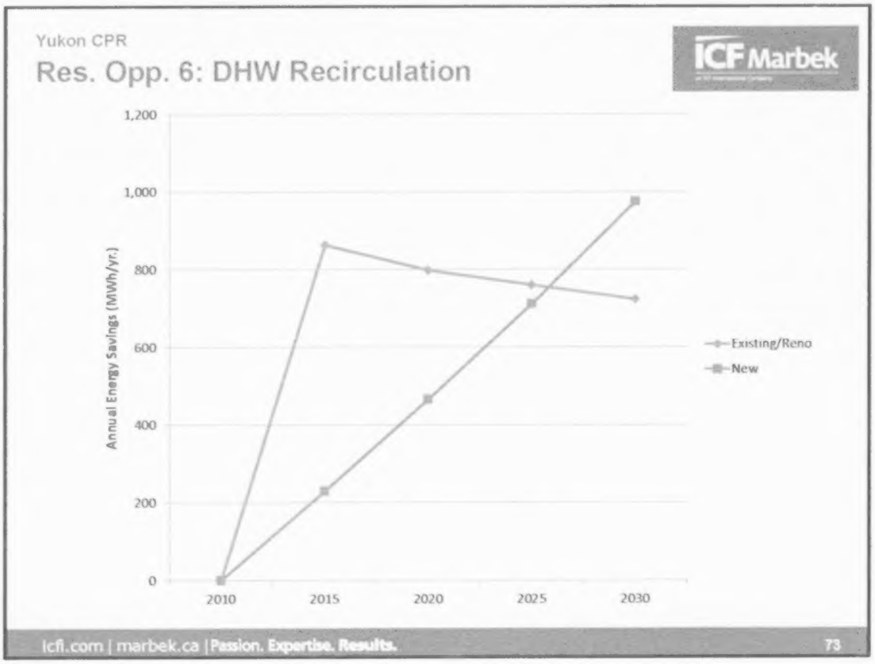
Res. Opp. 6: DHW Recirculation

- Technology Description
  - Install a pump at fixture farthest from DHW tank, to circulate water back through a dedicated line or the cold water lines, to reduce arrival time of hot water by 75-80%
- Discussion dwelling type: applies to all, but start with detached houses on hydro grid
- Typical application
  - Cost: just over $700
  - Useful life: 18 years
  - Savings: 16% of DHW energy



Res. Opp. 6: DHW Recirculation

- Financial and Economic Indicators
  - 13 year simple payback
  - CCE of 14.8 cents/kWh
  - Basis of assessment: full cost
- Eligible Participants
  - Approx. 6,800 dwellings by 2030, including all Yukon
  - Includes only dwellings with electric DHW
  - Eligible immediately



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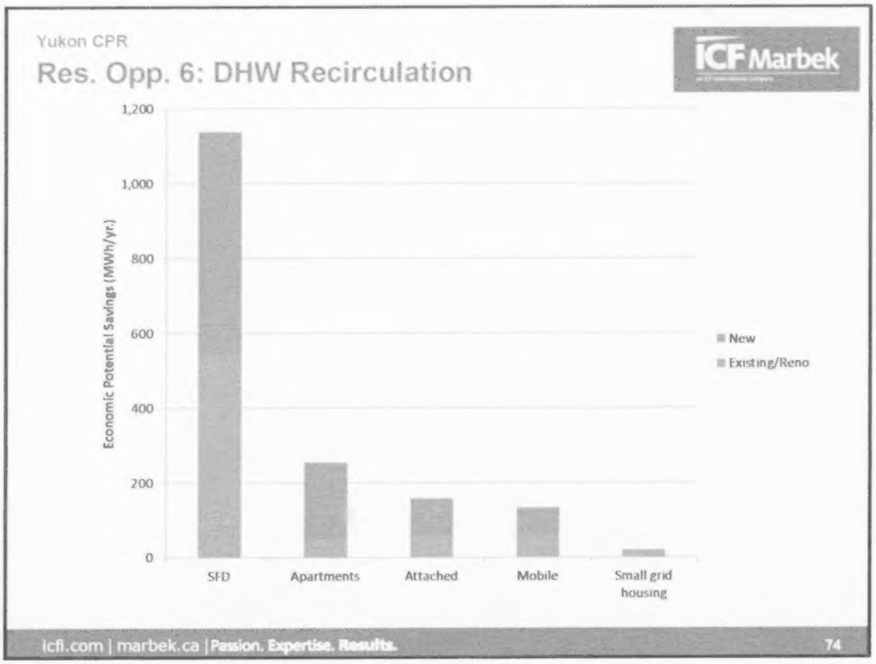
Res. Opp. 6: DHW Recirculation



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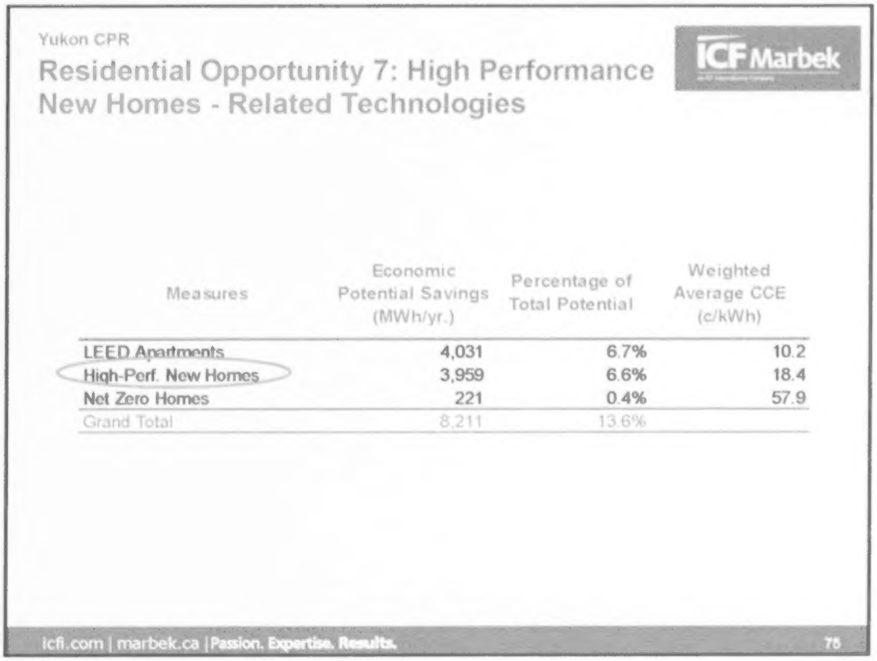
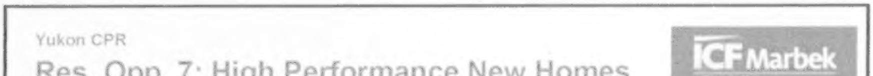
Res. Opp. 6: DHW Recirculation



Residential Opportunity 7: High Performance New Homes - Related Technologies

Measures	Economic Potential Savings (MWh/yr.)	Percentage of Total Potential	Weighted Average CCE (c/kWh)
LEED Apartments	4,031	6.7%	10.2
High-Perf. New Homes	3,959	6.6%	18.4
Net Zero Homes	221	0.4%	57.9
Grand Total	8,211	13.6%	



Res. Opp. 7: High Performance New Homes

- Technology Description
  - Construct new dwellings to meet a performance standard of EGH-85
- Discussion dwelling type: new single detached houses on the hydro grid
- Typical application
  - Cost: assumed to be $10,000 incremental
  - Useful life: 30 years
  - Savings: 25% of HVAC and DHW energy

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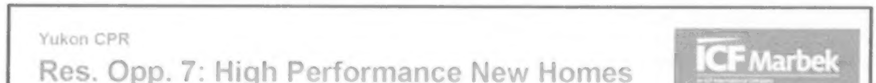
Res. Opp. 7: High Performance New Homes

- Financial and Economic Indicators
  - 24 year simple payback
  - CCE of 18.4 cents/kWh
  - Basis of assessment: incremental cost
- Eligible Participants
  - Approx. 1,000 dwellings by 2030, including all Yukon
  - Would target only electrically heated dwellings
  - Eligible immediately for new homes
  - Collaborate with other agencies to broaden program beyond electrically heated dwellings?



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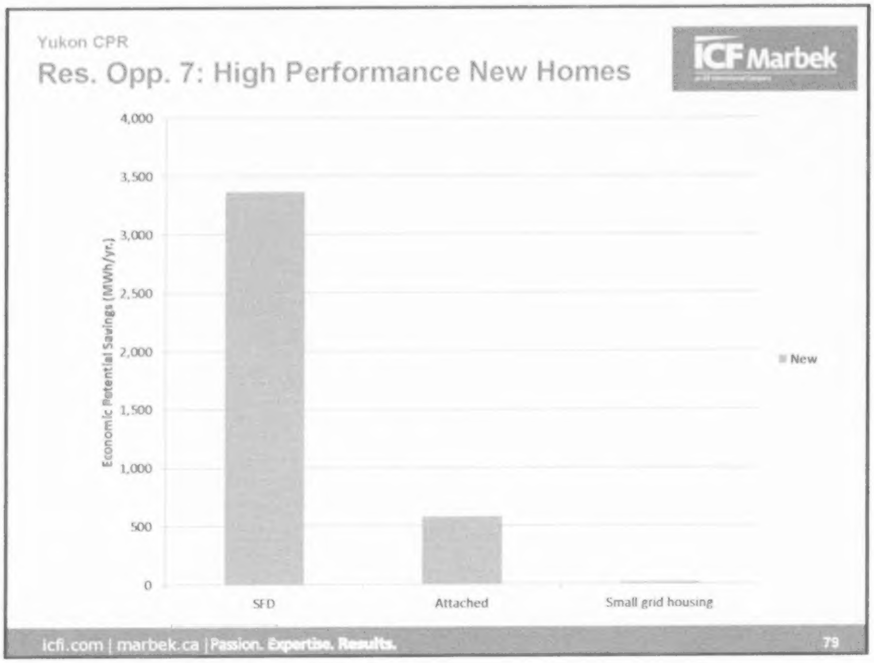
Res. Opp. 7: High Performance New Homes



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Res. Opp. 7: High Performance New Homes

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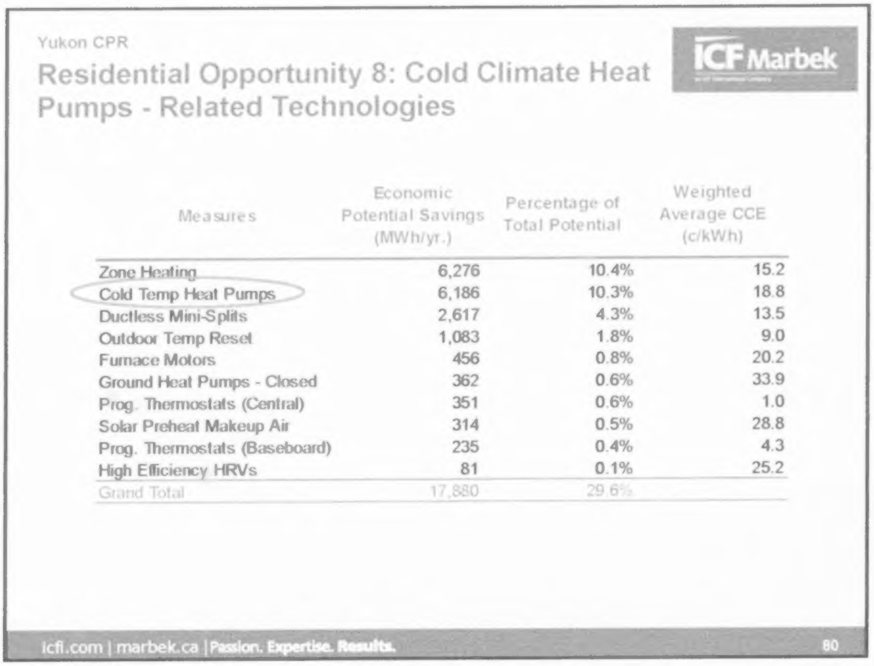

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Residential Opportunity 8: Cold Climate Heat Pumps - Related Technologies

Measures	Economic Potential Savings (MWh/yr.)	Percentage of Total Potential	Weighted Average CCE (c/kWh)
Zone Heating	6,276	10.4%	15.2
Cold Temp Heat Pumps	6,186	10.3%	18.8
Ductless Mini-Splits	2,617	4.3%	13.5
Outdoor Temp Reset	1,083	1.8%	9.0
Furnace Motors	456	0.8%	20.2
Ground Heat Pumps - Closed	362	0.6%	33.9
Prog. Thermostats (Central)	351	0.6%	1.0
Solar Preheat Makeup Air	314	0.5%	28.8
Prog. Thermostats (Baseboard)	235	0.4%	4.3
High Efficiency HRVs	81	0.1%	25.2
Grand Total	17,880	29.6%	

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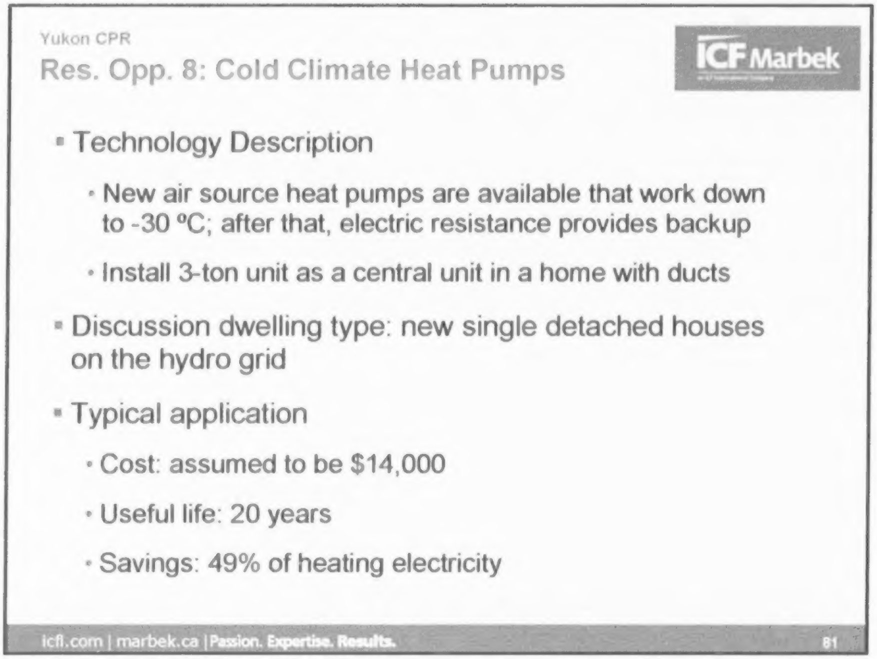

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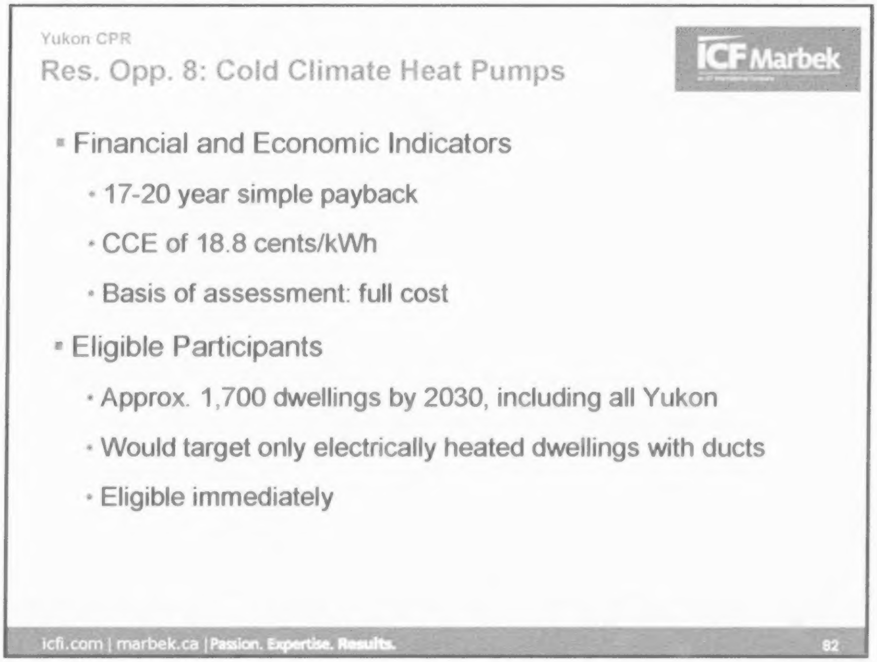
Res. Opp. 8: Cold Climate Heat Pumps

- Technology Description
  - New air source heat pumps are available that work down to -30 ºC; after that, electric resistance provides backup
  - Install 3-ton unit as a central unit in a home with ducts
- Discussion dwelling type: new single detached houses on the hydro grid
- Typical application
  - Cost: assumed to be $14,000
  - Useful life: 20 years
  - Savings: 49% of heating electricity



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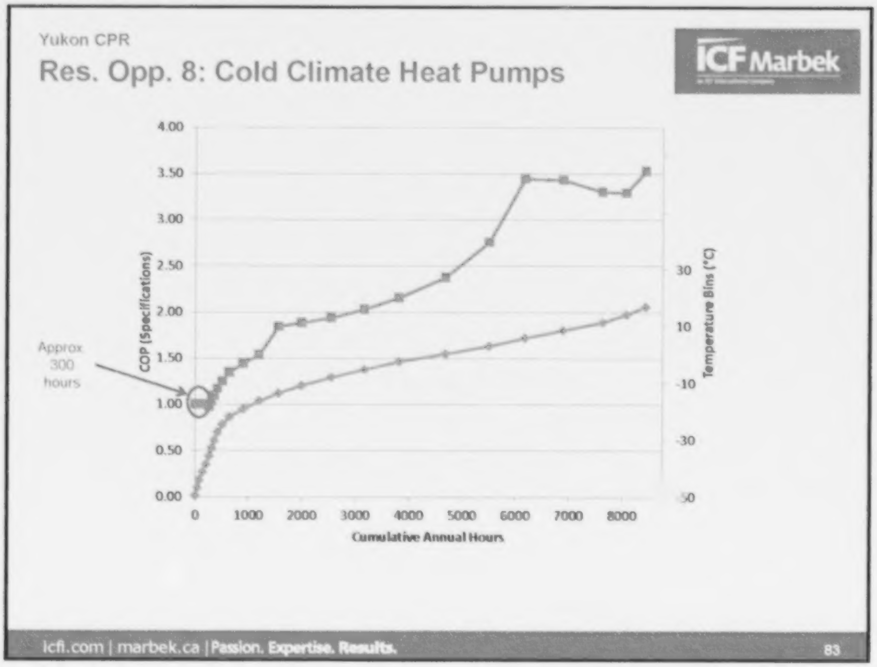
Res. Opp. 8: Cold Climate Heat Pumps

- Financial and Economic Indicators
  - 17-20 year simple payback
  - CCE of 18.8 cents/kWh
  - Basis of assessment: full cost
- Eligible Participants
  - Approx. 1,700 dwellings by 2030, including all Yukon
  - Would target only electrically heated dwellings with ducts
  - Eligible immediately



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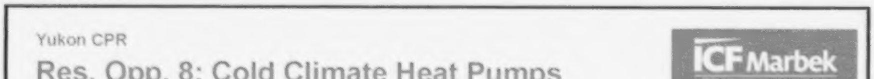
Res. Opp. 8: Cold Climate Heat Pumps

Approx 300 hours



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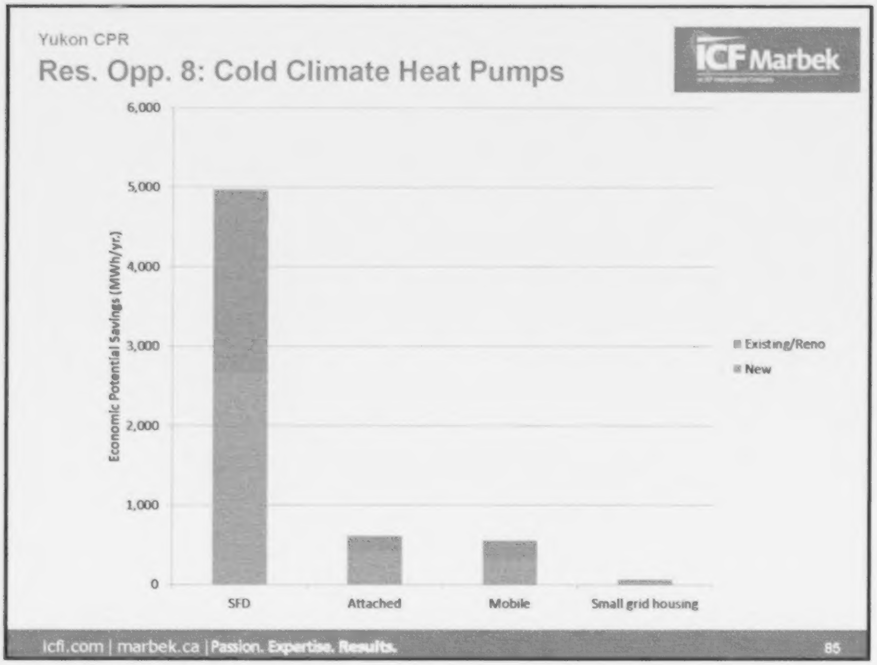
Res. Opp. 8: Cold Climate Heat Pumps



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Res. Opp. 8: Cold Climate Heat Pumps

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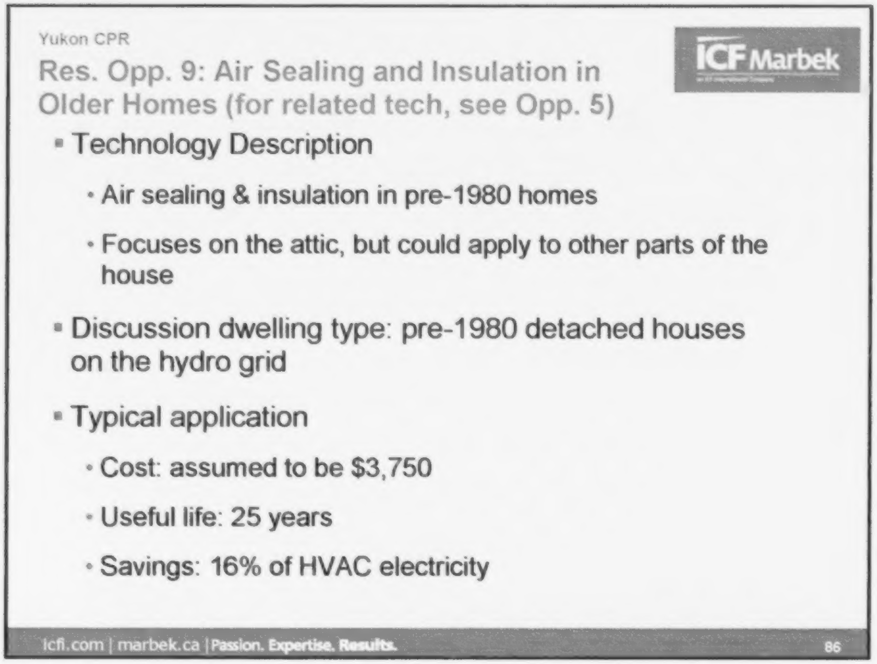

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Res. Opp. 9: Air Sealing and Insulation in Older Homes (for related tech, see Opp. 5)

- Technology Description
  - Air sealing & insulation in pre-1980 homes
  - Focuses on the attic, but could apply to other parts of the house
- Discussion dwelling type: pre-1980 detached houses on the hydro grid
- Typical application
  - Cost: assumed to be $3,750
  - Useful life: 25 years
  - Savings: 16% of HVAC electricity

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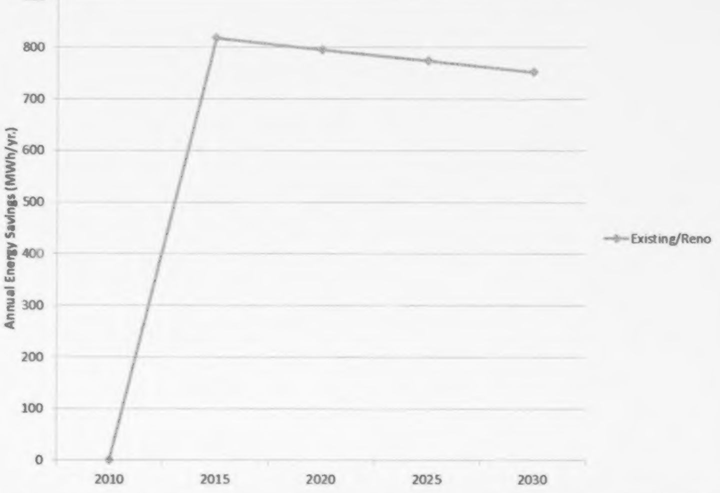
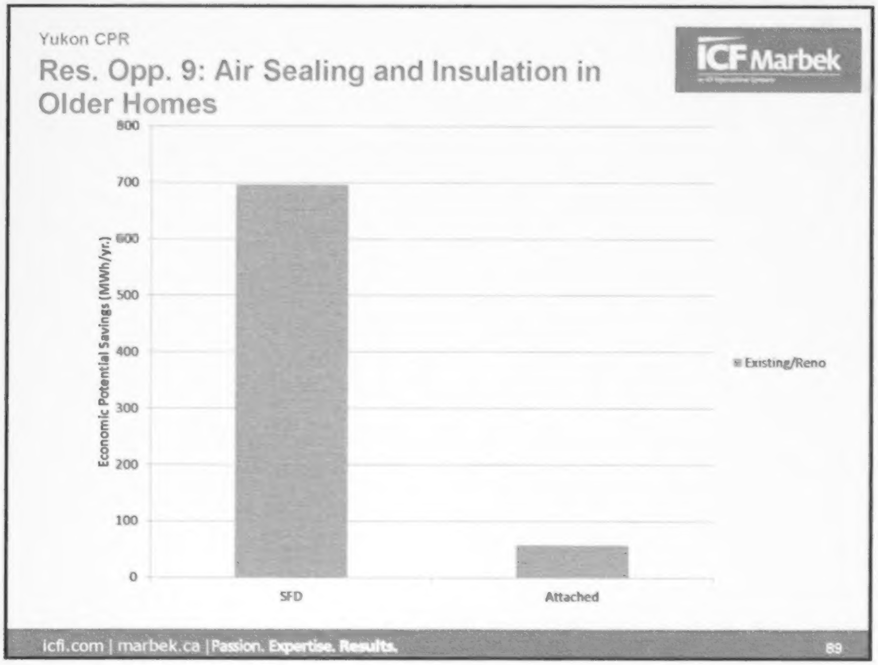
Res. Opp. 9: Air Sealing and Insulation in Older Homes

- Financial and Economic Indicators
  - 15 year simple payback
  - CCE of 11.1 cents/kWh
  - Basis of assessment: full cost
- Eligible Participants
  - Approx. 300 dwellings by 2030, including all Yukon
  - Would target only electrically heated, older dwellings
  - Eligible immediately
  - Could broaden the program by collaborating to include non-electrically heated old homes

Res. Opp. 9: Air Sealing and Insulation in Older Homes





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Res. Opp. 9: Air Sealing and Insulation in Older Homes

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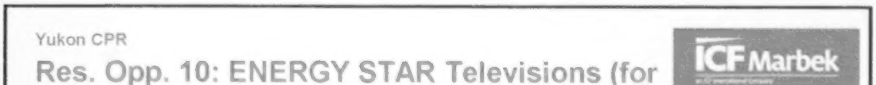

Yukon CPR

Res. Opp. 10: ENERGY STAR Televisions (for related tech, see Opp. 3)

- Technology Description
  - ENERGY STAR 42" television
- Discussion dwelling type: applies to all, but start with detached houses on hydro grid
- Typical application
  - Cost: assumed to be $125 incremental
  - Useful life: 10 years
  - Savings: 25% of television electricity

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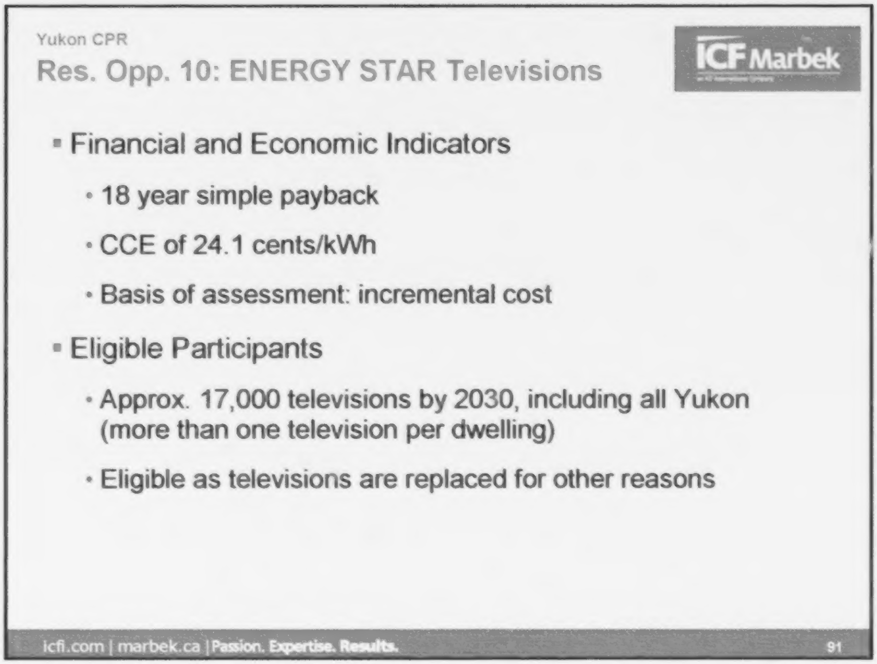

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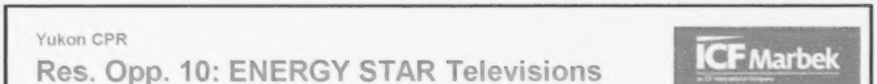
Res. Opp. 10: ENERGY STAR Televisions

- Financial and Economic Indicators
  - 18 year simple payback
  - CCE of 24.1 cents/kWh
  - Basis of assessment: incremental cost
- Eligible Participants
  - Approx. 17,000 televisions by 2030, including all Yukon (more than one television per dwelling)
  - Eligible as televisions are replaced for other reasons



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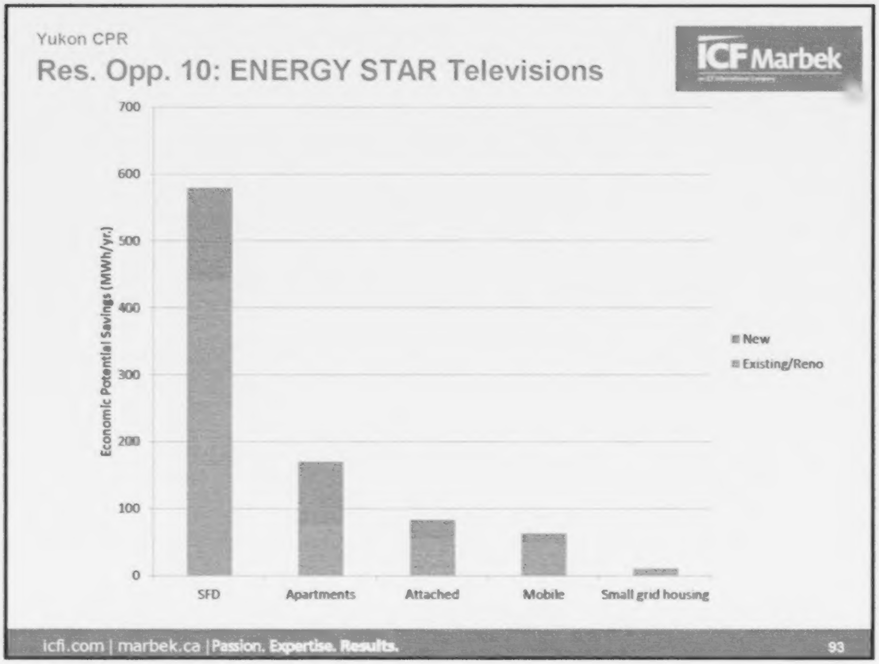
Res. Opp. 10: ENERGY STAR Televisions



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Res. Opp. 10: ENERGY STAR Televisions

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Wrap Up

- Closing remarks
- Next steps
- Roundtable comments on the workshop
  - Did the day meet your expectations?
  - Do you have any outstanding questions, concerns, or suggestions?
  - Did we miss any significant technology opportunities?
- Thank you all around!

Appendix I Background-Section 10: Achievable Workshop Measure Worksheets

YUKON ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R1: ENERGY STAR Clothes Washers

	Yukon		COMMENTS
	Hydro Grid Dwellings		
	2015	2030	
MEASURE INFORMATION			
CCE (c/kWh)	14.9		6 incremental; >15 full
Simple Payback (years)	6.0		6 incremental; >15 full
ECONOMIC POTENTIAL (number of washers)			
Total Number of Dwellings	15,076	19,639	
Washers Affected (Cumulative)	8,577	11,386	
Washers Affected (Per Year)	1,715	569	
PARTICIPATION RATES (%)			
BAU (Business As Usual) Marketing		65%	Curve B
Aggressive Marketing		80%	Curve C
ACHIEVABLE POTENTIAL (number of washers)			
BAU Marketing		7,401	
Aggressive Marketing		9,109	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes		same	
Apartments		lower	
New Homes		higher	
Large Diesel Grid Homes		same	
Small Diesel and Old Crow Homes		lower	barrier: higher cost to ship white goods (esp. Old crow)
Government Accounts		same	Split incentive - Yukon housing pays energy, but does not supply appliances
Other Appliance Technologies:			
ENERGY STAR Refrigerators		lower	(features more important than EE)
ENERGY STAR Freezers		same-ish	?
ENERGY STAR Dishwashers		higher	incremental cost lower
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			High
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			Trade ally training and collaboration, incentives, education, performance standards

YUKON ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R2: Block Heater Timers

	Yukon		COMMENTS
	Hydro Grid Dwellings		
	2015	2030	
MEASURE INFORMATION			
CCE (¢/kWh)	4.4		
Simple Payback (years)	4.0		
ECONOMIC POTENTIAL (number of dwellings)			
Total Number of Dwellings	15,076	19,639	
Dwellings Affected (Cumulative)	7,162	9,330	
Dwellings Affected (Per Year)	1,432	466	
PARTICIPATION RATES (%)			
BAU (Business As Usual) Marketing		50%	Curve B (shallow)
Aggressive Marketing		70%	Curve B
ACHIEVABLE POTENTIAL (number of dwellings)			
BAU Marketing		4,665	
Aggressive Marketing		6,531	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes		same	
Apartments		lower	
New Homes		same	could be installed during construction. Spec builders may not build these in as an extra. Code is an option for WH
Large Diesel Grid Homes		same	
Small Diesel and Old Crow Homes		same	not many cars in OC
Government Accounts		same	
Other Miscellaneous Technologies:			
Heat Pump Spa Heaters		lower	
Hot Tub Pump Timers		same	
Car Warmer Timers		same	
Efficient Spa Pumps			
Battery Blanket Timers		same	
Solar Spa Preheat			
Insulated Hot Tub Covers			
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			Low
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			Product testing, educational materials, media communications, testimonials, point of sale materials, direct assistance with programming.

YUKON ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R3: Power Bars (PCs)

	Yukon		COMMENTS
	Hydro Grid Dwellings		
	2015	2030	
MEASURE INFORMATION			
CCE (c/kWh)	8.4		
Simple Payback (years)	6.0		
ECONOMIC POTENTIAL (number of computers)			
Total Number of Dwellings	15,076	19,639	
Computers Affected (Cumulative)	21,859	28,476	
Computers Affected (Per Year)	4,372	1,424	
PARTICIPATION RATES (%)			
BAU (Business As Usual) Marketing		20%	Shallow Curve B
Aggressive Marketing		40%	Shallow Curve B
ACHIEVABLE POTENTIAL (number of computers)			
BAU Marketing		5,695	
Aggressive Marketing		11,390	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes	same		
Apartments	same		
New Homes	same		
Large Diesel Grid Homes	slightly lower		
Small Diesel and Old Crow Homes	slightly lower		
Government Accounts	same		
Other Electronic Technologies:			
Future Electronics Improvements			Placeholder measure
Power Bars (TVs)	same		
ENERGY STAR Printers and Faxes	higher		(as per white goods?)
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			Low
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			Product testing, educational materials, media communications, case studies, point of sale materials, collaboration with corporate IT departments.

YUKON ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R4: LED Lamps

	Yukon		COMMENTS
	Hydro Grid Dwellings		
	2015	2030	
MEASURE INFORMATION			
CCE (¢/kWh)	11.5		
Simple Payback (years)	15.0		
ECONOMIC POTENTIAL (number of dwellings)			
Total Number of Dwellings	15,076	19,639	
Dwellings Affected (Cumulative)	14,925	19,443	570,000 fixtures
Dwellings Affected (Per Year)	2,985	972	
PARTICIPATION RATES (%)			
BAU (Business As Usual) Marketing		70%	Curve B
Aggressive Marketing		85%	Curve B
ACHIEVABLE POTENTIAL (number of dwellings)			
BAU Marketing		13,610	
Aggressive Marketing		16,526	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes	same		
Apartments	same		
New Homes	same		
Large Diesel Grid Homes	slightly lower		
Small Diesel and Old Crow Homes	slightly lower		
Government Accounts	same		
Other Lighting Technologies:			
Various Indoor CFLs			flat, then reducing. Limited opportunity to recycle makes them hard to promote
T8 Fixtures			
Pulse Start MH Sentinel Lights			
Spot or Task Lighting			
Motion Detectors - Indoor/Outdoor			
CFLs - Outdoor			
LED Holiday - Indoor/Outdoor			
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			High
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			Product testing, qualification of products, educational materials, incentives.

YUKON ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R5: Wall Insulation

	Yukon		COMMENTS
	Hydro Grid Dwellings		
	2015	2030	
MEASURE INFORMATION			
CCE (c/kWh)	10.6		
Simple Payback (years)	14-17		
ECONOMIC POTENTIAL (number of dwellings)			
Total Number of Dwellings	2,382	4,976	
Dwellings Affected (Cumulative)	715	625	
Dwellings Affected (Per Year)	143	31	
PARTICIPATION RATES (%)			
BAU (Business As Usual) Marketing		3%	Curve B
Aggressive Marketing		17%	Curve B
ACHIEVABLE POTENTIAL (number of dwellings)			
BAU Marketing		21	
Aggressive Marketing		104	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes	lower		
Government Accounts	same		
Other Existing Envelope Improvements:			
Attic Insulation			
Triple Glazed Windows			
Optimized Glazing for Passive Solar			
Slab Insulation			
Basement Insulation	higher		
Quadruple Glazed Windows			
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			High
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			Financing, demonstrations, education of both homeowners and contractors, utility pre-qualification or certification of contractors, and partnerships with other organizations.

YUKON ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R6: DHW Recirculation

	Yukon		COMMENTS
	Hydro Grid Dwellings		
	2015	2030	
MEASURE INFORMATION			
CCE (c/kWh)	14.8		
Simple Payback (years)	13.0		
ECONOMIC POTENTIAL (number of dwellings)			
Total Number of Dwellings	15,076	19,639	
Dwellings Affected (Cumulative)	5,059	6,590	
Dwellings Affected (Per Year)	1,012	330	
PARTICIPATION RATES (%)			
BAU (Business As Usual) Marketing		5%	Curve B
Aggressive Marketing		30%	Curve B
ACHIEVABLE POTENTIAL (number of dwellings)			
BAU Marketing		330	
Aggressive Marketing		1,977	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes	same		
Apartments	lower		some have central recirc
New Homes			
Large Diesel Grid Homes	slightly higher		
Small Diesel and Old Crow Homes	higher		more trucked water
Government Accounts			
Other DHW Technologies:			
DHW Piping Optimization			
DHW Pipe Insulation			
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			Medium
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			Marketing as a luxury item, marketing with other DHW measures, or selling based on its water conservation features

YUKON ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R7: High Performance New Homes

	Yukon		COMMENTS
	Hydro Grid Dwellings		
	2015	2030	
MEASURE INFORMATION			
CCE (c/kWh)	18.4		
Simple Payback (years)	24.0		
ECONOMIC POTENTIAL (number of dwellings)			
Total Number of Dwellings	1,265	5,828	
Dwellings Affected (Cumulative)	223	1,026	
Dwellings Affected (Per Year)	45	51	
PARTICIPATION RATES (%)			
BAU (Business As Usual) Marketing		95%	Curve D (in 2022)
Aggressive Marketing		95%	D (in 2017) Whitehorse only
ACHIEVABLE POTENTIAL (number of dwellings)			
BAU Marketing		975	
Aggressive Marketing		975	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes	same		
Government Accounts	same		
Other New Construction Options:			
LEED Apartments			To discuss tomorrow in Commercial session
Net Zero Homes			Discuss PV in CSRAE session on Thursday?
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			High
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			Code changes, contests among builders, green mortgages, labelling and branding, testimonials, free rating services, marketing based on non-energy benefits

YUKON ACHIEVABLE POTENTIAL WORKSHOP - RESIDENTIAL SECTOR

R8: Cold Climate Heat Pumps

	Yukon		COMMENTS
	Hydro Grid Dwellings		
	2015	2030	
MEASURE INFORMATION			
CCE (c/kWh)	18.8		
Simple Payback (years)	17-20		
ECONOMIC POTENTIAL (number of dwellings)			
Total Number of Dwellings	2,382	4,976	
Dwellings Affected (Cumulative)	957	1,724	
Dwellings Affected (Per Year)	191	86	
PARTICIPATION RATES (%)			
BAU (Business As Usual) Marketing		25%	Curve B
Aggressive Marketing		75%	Curve B
ACHIEVABLE POTENTIAL (number of dwellings)			
BAU Marketing		431	
Aggressive Marketing		1,293	
PARTICIPATION RATES (relative to discussion scenario)			
Attached Homes			
New Homes		slightly higher	few ducted, elec htd homes
Government Accounts			
Other Heating Equipment Technologies:			
Ductless Mini-Splits		lower	11-13K 2 zone system.
Zone Heating		lower	
Programmable Thermostats (Basebd)		higher	
Outdoor Temperature Reset			
Furnace Motors			
Ground Source Heat Pumps			
Solar Preheat Makeup Air			
Programmable Thermostats (Central)		higher	
OTHER PARAMETERS			
Sensitivity to Incentives (High, Medium, Low)			High
Most Critical Program Support Type(s) (e.g. Trade Ally Training, Certification, Technical Workshops, etc.)			Incentives, education programs, validation or certification of installers, product testing, collaboration with other organizations